# The Electrical World.

VOL. XXIV. NEW YORK, NOVEMBER 10, 1894. No. 19.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited,

253 Broadway, New York.

Established 1874. Incorporated 1889.

*Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.*

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 927 Chestnut Street.

*SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,*
in the U. S., Canada or Mexico; other Postal Union countries, $6.

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253 Broadway, New York.

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### AMERICAN MANUFACTURES EXHIBITION.

The movement in favor of holding exhibitions of American manufactures, first in the City of Mexico and later in the chief South American Republics, is gathering strength, and arrangements are now being completed to hold a convention of manufacturers in order to perfect the necessary details. The plan, which has met with the hearty approval of President Diaz, of Mexico, also includes the joint display of the products of the Spanish-American Republics, thus imparting an international character to the exhibitions and largely enhancing their interest and value for achieving the end in view. That such exhibitions would accomplish a good end cannot be doubted, and we trust that the efforts of the energetic and patriotic gentlemen at the head of the enterprise will result in a most complete success.

### ELECTRIC LIGHT GLOBES.

The Digest of this issue contains an account of a new electric light globe recently invented in France which, from the description, appears to represent a notable improvement, and deserves careful attention, particularly on account of the great extension it promises to the use of the arc in interior lighting. It will be seen that by a proper proportioning of the exterior horizontal and interior vertical corrugations any desired distribution of light can be obtained; thus, for interior lighting a uniform diffusion is possible and the question of a proper distribution of light in street illumination is solved. At first sight it would seem that with this system absorption might reach a serious figure, but it is stated that with the corrugations so designed as to avoid total reflection, the loss may vary from only nine to thirteen per cent., which is less than what has sometimes been observed with plain glass globes, some figures in the latter case being as high as twenty per cent.

### PRACTICAL COMPOUNDING OF DYNAMOS.

In many text books the subject of compounding of dynamos is so involved through the introduction of equations, curves and the introduction of extraneous considerations, that the student often has difficulty of clearly understanding what is really a simple matter. Those who have encountered any difficulty in understanding the subject will find that the article by Mr. George T. Hanchett, which we print elsewhere, puts the matter in a simple and entirely practical manner. In connection with the subject of over-compounding the student should also consult the article on this subject by Prof. E. P. Roberts, which appeared in a recent issue, as it is there shown that where dynamos are connected in parallel, the dynamo compounds only for the current passing through its armature, with the consequence that with a light load on the line, but with part of the dynamos switched off and the others under full load, the over-compounding will cause an excess of E. M. F. at the lamps. It will be understood that the remarks of Mr. Hanchett are based upon the presumption that the magnetic circuit of the dynamo has been properly designed; that is, that a proper relation exists between the magneto-motive force and the reluctance, so that the magnetization is carried at a point that justifies the considerations mentioned.

### FLY WHEEL ACCIDENTS IN POWER HOUSES.

In this issue we publish several further interesting contributions to the instructive discussion on fly wheels which has been appearing in our columns, and also print the first part of an exhaustive article by Prof. Flather on the subject of fly wheel accidents in general. Mr. Coykendall still insists upon the importance of the tangential stress due to a sudden change of load, and which some of those who have taken part in the discussion have confused with the tangential component of the centrifugal force. We cannot agree,

however, that the former is the same kind of stress as that due to centritugal force, and that from it an accident may occur in the same way as from the latter. The tangential component of the centrifugal force produces a strain in the rim of a fly wheel of the same character as that produced by steam pressure in the shell of a boiler. The strain produced by the sudden imposition of a load and consequent sudden change of speed, however, is in the nature of a shearing strain as far as the rim itself is concerned, and would appear to be of such an order as to be entirely negligible in the rim. On the other hand the stress on the pulley arms due to this cause may be excessive. If weakest at the junction of the rim, the arms thereby may be sheared at the rim, though it is much more probable, on account of the influence of leverage, that they will part at some point between the hub and the rim. If, however, the fly wheel is also used as a driver, in case of a sudden imposition of load the additional strain of the belt would reduce the strain on the arms, as the pull of the belt would be opposite to the leverage on the arms due to the stress arising from change of momentum of the rim. The main point made by Mr. Coykendall —that a sudden change in the momentum of a fly wheel may produce a sufficient stress to fracture the arms—seems to be unquestionable. Nevertheless, it is probable that centrifugal stress due to increased speed is by far the more prevalent cause of fly wheel accidents.

CABLE ROADS.

An article in a London electrical contemporary of high standing, in which a comparison is made between electrical and cable roads, concludes that "in the case of street tramways it will be difficult to find any method of haulage which, with a fair traffic, can be operated more economically than the cable system." A good illustration showing that this conclusion is not correct, at least not in this country, is a case in Philadelphia in which city two of the most important lines are soon to be changed to electric roads that for a number of years have been operated by cable. Although they were very unsatisfactory to citizens, this cannot be said to be the reason for the change, a company like the owners of these roads considering the dollars and cents only, and it may therefore be safely assumed that it has assured itself that the profits would be greater, notwithstanding the increased capital required and the almost total loss of the cable machinery and conduits. It is said that the conduits are rotting although they are not many years old. Whether the difference between the results in England and America are due to the poor construction of electric roads there, or to the poor construction of cable roads here, remains to be determined, but at all events the conclusions quoted above ought not to be assumed as applying equally well here. If in the above quotation the words "will be" are replaced by "was not" it will apply to this country. In justice to the cable system it might be remarked that in both of these Philadelphia lines there are but few steep grades and it is on lines with heavy and frequent grades that any possible advantage of the cable system becomes more apparent. As we write it is announced that two important cable roads in Chicago are also to be changed to electric roads.

THE ELECTRICAL TRANSMISSION OF POWER.

In this issue we begin a series of articles from the pen of Dr. Louis Bell on the electrical transmission of power, which, we think we can say with confidence, will be of a value to the electrical fraternity comparable to that other notable pioneer work, "The Electric Railway in Theory and Practice," of which Dr. Bell was a joint author. It will be remembered that at the time the latter work appeared the state of knowledge on the subject of street railway theory and practice bore a great resemblance to the present condition of knowledge concerning the electrical transmission of power. As far as the more practical questions are concerned, the condition is even more unfavorable with respect to the latter, as information on the practical part of the subject has been confined to very few persons, none of whom has heretofore shown any particular desire to impart it to the public. While much has been written on the theoretical side, it has been fragmentary in character and in most cases so highly mathematical and so largely lacking in a practical basis of fact as to have little other than an abstract interest. The electrical public is to be congratulated that Dr. Bell has undertaken the task of treating the subject in a definitative and comprehensive manner, and with particular reference to its practical engineering features. His professional connection with this branch during the last several years, during which time he has been a potent factor in its development, united with a thorough grasp of all of the higher principles concerned, and the possession of a most lucid and graceful literary style, all give assurance of a work that will occupy a high place in engineering literature. As will be seen, the subject is introduced by an exposition of the elementary electrical principles concerned, and it will be noted that Dr. Bell's treatment is founded on the very latest conceptions, being much in advance of the usual text-books in this respcet. The exposition will be a logical one, and all of the points taken up turn that are necessary to a thorough understanding of the important questions to be met in practice, but theory will be introduced only as a means of attaining a practical end. The illustrations for the series will be carefully prepared, largely from original sources, and in every direction no pains will be spared to make the work one that will answer in every respect the need that now exists for a thorough treatise on this most important and growing branch of electrical engineering.

## Magnetic Qualities of Gun Steel.

The October number of the "Journal of the United States Artillery" contain a contribution from Lieut. Geo. O. Squier, U. S. A., on "Some Tests of the Magnetic Qualities of Gun Steel." The article embodies the results of a series of experiments recently made in the laboratory of the Johns Hopkins University. The steel was a muzzle-ring from a 3.2-inch breech-loading rifle cut from the gun as the last operation, and therefore furnishing a sample of the physical condition of a finished gun. The steel originally came from the Bethlehem Iron Company, of Bethlehem, Pennsylvania, and is a low steel of remarkable physical qualities, forged, oil tempered and annealed. The results of the tests are here given in the author's own words:

"The very superficial tests made indicate that the steel of our new guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities, and, but for the cost, could be used for the construction of electrical machinery with very efficient results. In fact, a comparison of the $\mathfrak{B}$ $\mathfrak{H}$ curve with Hopkinson's curve for the best wrought iron shows them to be practically the same in character, and when further compared with the curves for the average steel castings from various manufacturers in the United States, we find magnetic values about 8 per cent. in favor of gun-steel. This indicates an improvement produced by forging as compared with simple steel castings, and for marine dynamos, and in gun-training motors where space is valuable, steel of high permeability will, probably, be exclusively used in the future.

"Passing to the hysteresis behavior, it was observed that the hysteresis curve is of the characteristic 'square-shouldered' type, which is often found in steel and almost always in annealed soft iron. This bend in the curve, which is not a decided 'knee' in this case, divides the curves into parts corresponding to the stable and unstable conditions in Ewing's theory. The rate of descent from the bend during the reversal of the magnetism is remarkably rapid and uniform, while the comparatively small area inclosed shows the effect of annealing. Hardening steel increases hysteresis loss so that samples with exactly the same chemical constitution show very different losses, depending upon whether they have been annealed or hardened.

"From data which has but recently come to hand, it would appear that there is a connection between the magnetic qualities and the physical conditions of steel as indicated by a combination of high physical qualities; for instance, nickel-steel, possessing in an unusual degree a combination of high elastic limit and ductility, is also found to possess exceptionally high magnetic permeability."

## Dayload.

At the opening of the central station at Worcester in England, the advantages of electric cooking were shown by cooking a number of the dishes at the banquet by an electric current generated by the waterfall three miles distant; the indirect object was to advertise electric cooking in order to increase the day load.

## Electrical Power Transmission—I.

BY LOUIS BELL.

*Concerning Electrical Energy.*

1. It has long been the fashion to speak of what we are pleased to call electricity as a mysterious "force" and to attribute to everything connected with it occult characteristics better suited to mediæval wizardry than to modern science. This unhappy condition of affairs has, in the main, come about through indistinctness of some of our fundamental ideas and inexactitude in expressing them.

To speak specifically, there has been even in the minds and writings of some who ought to know better, a tendency toward confusing the somewhat hazy individuality of "electricity" with the sharply defined properties of electrical energy. We have been so overrun by theories of electricity, two-fluid, one-fluid, and non-fluid; with electrically "charged" atoms and duplex ethers, that we have well nigh forgotten the very great uncertainty as to its concrete existence. Even admitting it to be an entity it most assuredly is not a force mysterious or otherwise. Electrical force there is, and electrical energy there is, and with them we can freely experiment, but for most practical purposes "electricity" is merely the factor connecting the two. It is related to electrical energy much as that other hypothetical fluid "caloric" was supposed to be related to heat energy. The analogy is not exact but it nevertheless expresses a distinct idea.

The day has passed wherein we were at liberty to think of "electricity" as flowing through a material tube or as plastered upon bodies like a coat of paint. The things with which we have now to deal are the various factors of electrical energy.

It is the purpose of this chapter to treat of that form of energy which we denominate electrical, to discuss its relation to other forms of energy and the transformations which they may reciprocally undergo.

2. Speaking broadly, *energy* is power of doing work. The energy of a body at any moment represents its inherent capacity for doing work of some sort on other bodies. This, however, must not be understood as implying that the aforesaid energy is limited by our power of utilizing it. We may or may not be able to employ it to advantage or under possible conditions. As an example take the massive weight of a pile driver. Raised to its full height it possesses a certain amount of gravitational energy—a possibility of doing useful work. This energy is temporarily unemployed and appears only as a stress on the supporting rope and framework. Under these circumstances, wherein the energy exists in static form, it is generally known as *potential* energy.

Now let the weight fall and with swiftly gathering velocity it strikes the pile and does work upon it, settling it deep into the mud. The energy due to the blow of the *moving weight*, energy of motion in other words, is called *kinetic*. But at the bottom of its fall the weight still has potential energy with reference to points below it, and we realize this as the pile settles lower and each successive blow becomes more terrific. At some point we are unable further to utilize the fall, and have then reached the limit of the *available* energy in this particular case.

We must not forget, however, that each time the weight was lifted, work had to be done against gravitation to give the weight its point of vantage with respect to available energy. This work was probably done by expending the energy of expanding steam—in other words, the energy of the steam has been transformed through doing work on the piston into kinetic energy of the latter, which, through doing work against gravitation, has been enabled again to reappear as the energy of a falling body, and to do work on the driven pile. And back of the steam energy is the heat energy, by which work is done on the water in the boiler, and yet back of this the chemical energy of the coal transformed into heat energy and doing work on the minute particles of iron in the boiler, for we now know that heat is a species of kinetic energy.

Even the work done on our pile is not permitted to go untransformed into energy. Part is transformed into heat energy through friction and compression, part into friction of the water, and tiny waves that may lift against gravity chips and pebbles on a distant shore. Other fractions go into the vibrational energy of sound, heating the weight so that it gives out warmth—radiant energy—to the hand when held near it, and the surrounding air, and electrical work done on the weight and neighboring objects, for the weight unquestionably receives a minute amount of electrical energy at each blow. Thus a comparatively simple mechanical process involves a long series of transformations of energy.

3. No energy is ever created or destroyed, it merely is changed in form to reappear elsewhere, and work done is the link between one form of energy and another. And we may lay down another law of almost as serious import. *No form of energy is ever transformed completely into any other.*

On the contrary the general rule is that with each transformation several kinds of energy appear in varying amounts, and among them we may always reckon heat. The object of any transformation is usually a single form of energy, hence practically no such thing as perfectly efficient transformation can be obtained. The energy by-products for the most part cannot be utilized and are frittered away in useless work or storing up kinds of potential energy that cannot be employed.

The greatest loss is in heat which is dissipated through space and cannot be recovered.

Heat is therefore the worst enemy of efficiency.

From what has gone before we can readily appreciate that when we do work with the object of rendering available a particular kind of energy, the method must be intelligently selected else there will result useless by-products of energy which will seriously lower the efficiency of the operator.

Whenever possible we utilize potential energy already existing to secure a transformation. Thus if heat is wanted, the easiest way of getting it is to burn coal, and allow its energy to become kinetic as heat. If we want mechanical work done, we set heat energy to work in the most efficient way practicable. If electrical energy is desired we set the energy of steam at revolving the armature of a dynamo. If the right method of transformation is not taken, much of the energy will turn up in forms we do not want or cannot utilize. Burning coal is a very bad way of getting sound, just as playing a cornet is but a poor means of getting heat, although a fire does produce a trifling amount of sound, and a cornet by continual vibration must be warmed in a minute degree.

These seem, and perhaps are, extreme instances, but when we realize that, somewhat to the discredit of human ingenuity, only one twentieth of the electrical energy supplied to an incandescent lamp appears in the form of light, the comparison becomes grimly suggestive.

4. Understanding now that in order to obtain energy in any given form (such as electrical) particular methods of transformation must be used in order to secure anything like efficiency, we may look a little more closely at various types of energy to discover the characteristics that may indicate efficient methods of transformation, particularly as regards electrical energy.

Speaking broadly, one may divide energy into three classes:

1st. Those forms which have to do with movements of, or strains in, masses of matter. In this class may be included the ordinary forms of kinetic energy of moving bodies and the like.

2nd. Those which are concerned with movements of or strains in the molecules and atoms of which material bodies are compared. In this class we may reckon heat, latent and specific heats, energy of gases and perhaps chemical energy.

3rd. All forms of energy which have to do with strains which can exist outside of ordinary matter, i. e., every kind of radiant energy and presumably of electrical energy.

These classes are not absolutely distinct; for example, we do not know the relation of chemical energy to the third class, nor of gravitational energy to either, but such a division serves to keep clearly in our minds the kind of actions to which our attention is to be directed.

It is only within the past few years that we have been able with any certainty to classify electrical energy, and even now much remains to be learned. For a very long while it has been known that light, i. e., luminous energy, must be propagated through a medium quite distinct from ordinary matter and possessing certain remarkable properties. It was well known that luminous energy is transferred through this medium in vibratory or wave motion. Even the period of the vibrations and the lengths of the waves were accurately measured, and from these and similar measurements it has been possible to classify the mechanical properties of this medium, universally called "the ether" until we really know more about them than about the properties of many kinds of matter—a number of the rare metals for example.

The next important step was the discovery, verified in the most thorough manner, that what had been known as radiant heat, such as we get from the sun or any very hot body, is really energy of the same kind as light. That is, it was found to be energy of wave motion of precisely the same character and in the same medium, differing only in frequency and wave length. It also has turned out in similar fashion that what had been called "actinic" rays, that are active in affecting a photographic plate and

producing some other kinds of chemical action, are only light rays of shorter wave length than usual, and so ordinarily invisible to the eye.

5. So much having been ascertained it became clear that instead of three kinds of energy—"heat, light and actinism," we were really dealing with only one—radiant energy, vibrating energy in the ether, varying in effect as it varied in frequency. Speaking in an approximate way, such wave energy has a frequency of *six hundred thousand billion* vibrations per second and a velocity of propagation of about a hundred and eighty-five thousand miles per second, so that each wave is not far from one fifty-thousandth of an inch long. These dimensions are true of light waves; chemical action can be produced by waves of half the length, while so called heat rays may be composed of waves two or three times as long as those of light. Such figures are startling but they can be verified with an accuracy greater than that of ordinary mechanical measurements.

We see that this radiant energy is capable of producing various disturbances perceptible to our senses, such as chemical action, light and heat, and that these different effects simply correspond to waves of energy having different frequencies. This being so, it is not unnatural to suppose that at still different frequencies other effects might be noted. This idea gains further probability from the experimental fact that waves of very different frequencies traverse the ether with precisely the same velocity, showing no signs of slowing up or dying out, so that there seems to be no natural limit to their length.

6. During the past half dozen years it has been clearly shown that "radiant energy" is capable of producing profound electrical disturbances, such as violent oscillations of electrical energy in conducting bodies, and that these effects exist whatever the frequency of the ether waves concerned. This very important fact was clearly foreseen by Maxwell nearly twenty years ago, regarding light, and his prediction has been thoroughly verified through the persistant researches of the late Prof. Hertz and others.

This discovery is often expressed by saying that radiant energy is an electro magnetic disturbance, or that light is one kind of electrical action. It is more strictly accurate to say that radiant energy, just as it produces chemical disturbances on the photographic plate, affects the eye as light, and material bodies as heat, is also capable of producing electrical effects when transferred to the proper media. Most of our experiments on its electrical effects have been performed with waves many thousand times longer than those of light, but their general character has proved to be exactly the same.

A given substance may be differently related to waves of radiant energy of different lengths, but the phenomena are still essentially the same. For instance, a plate of hard rubber is thoroughly opaque to waves of a length corresponding to light, but is quite transparent to those of considerably greater length, such as can produce thermal or electrical effects. A plate of alum will let through light waves and very long waves, but will stop most of those which are efficient in producing heat. A sheet of metal is quite opaque to all waves of radiant energy. Hence, the fact noted long ago by Maxwell, that all good conductors are opaque to light although the converse is not true.

5. The substance of all this is, that the same sort of disturbance in the ether that produces light is also competent to set up electrical actions in material bodies and conversely, such actions may and do produce corresponding disturbances in the ether which are thus transferred to other bodies. Such a transference corresponds to all that we know concerning the velocity with which electrical and electro magnetic disturbances pass from body to body. It is equally certain that this velocity totally transcends anything we could hope to obtain from bodies having the dynamical properties of ordinary matter, while it does fit exactly the dynamical properties of the ether.

6. We are thus forced to the conclusion that when an electrical current, as we say, "passes along" a wire, whatever a "current" may be, it is not passed along from molecule to molecule in the wire as sound or heat would be, but that there is an immensely rapid transfer of energy in the neighboring ether that reaches all points of the wire almost simultaneously. It takes a measurable time for the electrical energy to reach and utilize the centre of the wire although its progress over the surface, thanks to the free ether outside, is immensely rapid.

Thus takes place what is generally called a "flow of electricity" along the wire. Looking at the process more closely, the nearest approach to flow is the transfer of energy along the wire by means of stresses in the ether which set up strains in the matter along their course.

Whenever we cause in matter the particular stress which we call electromotive force for lack of a more exact name, the resulting strain is electrification, and if the stress be applied at one point of a conducting body, the strain is immediately transferred to other points by the stresses and strains in the surrounding ether. Wherever this transference of strain exists we have an electrical current, although this name is generally reserved for those cases where there exists a perceptible transference of energy by the means aforesaid. If the conditions are such that energy must be steadily supplied to keep up the electromotive stress we have such a state of things as we find in a closed circuit containing a battery.

7. To cause such a flow of energy we must first find means of setting up electromotive stress capable of being propagated through the ether. Now atoms and molecules are the only handles by which we can get hold of the ether. In so far as we can work on them we can do work on the ether.

As a matter of fact we cannot do work of any kind on the molecules of a body without setting up electrical stresses of some sort. In most cases of mechanical work, which in the main produces stress on the molecules only by strains in the mass, the energy appears mainly as heat, and is only incidentally electrical, as for instance in the radiant energy from a heated body.

When, however, by any device we do work more directly on the molecules of a body, or on the atoms which compose the molecules, we are more than likely to transform this work into some manner of electrical energy. As a rough example of the two kinds of action just mentioned, pounding a body heats it without causing any considerable electrification, while on the other hand rubbing it even gently, sets up a considerable electrification without heating it noticeably.

In fact, for many centuries, friction was the only known method of causing electrification. Later, as is well known, it was discovered that certain sorts of chemical action, which has to do directly with interchanges of energy between molecules, were very potent in electrical effects. With this discovery came the ability to deal with steady transfers of electrical energy in considerable amount, (electric currents) instead of the relatively slight and transitory effects previously known, (electrification "frictional" electricity).

8. To clear up the real nature of this difference it is well to consider what we mean by saying that a body is electrified, or has an electrical charge. In other words, what is electrification? Not very many years ago this question would have been answered by saying that a quantity of a substance, positive electricity (or negative as the case might be), had been communicated to the body in question; that this remarkable substance could reside only at the surface of the body and was able to produce in surrounding bodies exactly an equal quantity of negative electricity; that this "charge" of electricity wou d repel another "charge" of the same substance placed near it, or attract a charge of its opposite, the other substance called negative electricity; and much more to the same effect. All this was a very convenient hypothesis,—it explained, after a fashion, the common facts and enabled investigators to discover many electrical relations and laws. But it expressed much more than there was reason to know. From the standpoint of our modern doctrines of energy electrification is a very different thing.

9. Let an electromotive stress (of whatever source) be applied to a body, a metallic sphere for example, long enough to transfer to it a finite amount of energy. This energy appears as stresses and strains in the ether everywhere about the body under consideration and thence extends to the molecules and atoms of neighboring bodies causing "induced charges." It is as if one were to fill a box with jelly, and then pull or push or twist a rod embedded in its centre. The result would be strains in the rod, the jelly and the box, and in a general way the total stress on the box would equal that on the rod. By proper means we could detect the strain all through the substance of the jelly, but most easily by its variations from place to place.

We do not know exactly what sort of a strain in our ether jelly is produced by electromotive stress, but we do know that it possesses the quality of endedness, so that the strains in the matter concerned, i.e. the ball and surrounding bodies, are equal and opposite.

In fact the two "charges" are merely the two ends of the same strain in the ether. They appear to us to be real attributes of the two opposed surfaces, because at these surfaces the dynamical constants, such as density, elasticity, etc., of the medium, through which the strain is propagated, change in value, and differences in state of strain there before manifest.

(To be Continued).

# ELECTRIC SYSTEM OF THE PHILADELPHIA TRACTION COMPANY

BY HERMANN S. HERING.

IV.

A rather novel feature in the car equipment is the Engineer's test car, which is furnished with testing instruments and is used to inspect the lines and to make various car tests. This car, which is numbered "999," and whose motors and trucks are identical with the regular 16 ft. car, is painted a dark red color to distinguish it from the other cars on the lines, and has a special folding step, which is opened or closed by the opening or closing of the platform gate. The purpose of this is to prevent any passengers from attempting to board the car while it is in use.

The interior, shown in Fig. 27, is handsomely finished and provided with easy chairs. The instruments are arranged on and below a shelf shown on the right hand side. On the shelf is a Weston 600-volt voltmeter and 100 ampere ammeter and the switches for controlling the circuits. Below the shelf is a Thomson recording

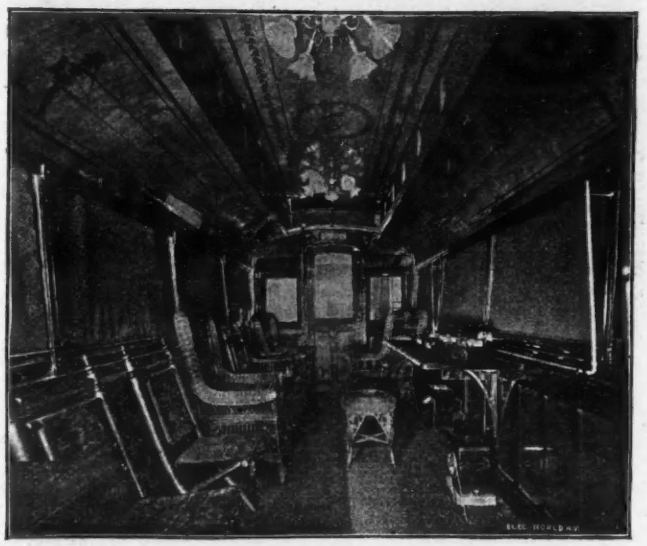


FIG. 27.—INTERIOR OF TEST CAR.

wattmeter and a Boyer Railway Speed Recorder, the dial of which is placed above the shelf. The tubing shown on the right side is a large U tube filled with mercury, with which the grades can be determined, and on the left side of the rear door is a column in which a counterweight moves and indicates the height of the trolley wire. Fig. 28 is a diagram of the connections of the instruments on the shelf. *A* is the ammeter; *B*, a switch for short-circuiting the ammeter; *C*, a double-throw switch for the purpose of connecting the ammeter in the circuit of a car coupled to the test car; *D*, a short-circuit switch for the wattmeter, and *E*, the voltmeter, connected between the trolley wire and ground. The ammeter circuit is arranged on the ground side of the motors, that is, it is put between the ground connection of the motors and the ground, in order that no shock can be obtained by any one touching the instruments. This car has been used considerably by the Board of Directors and it has become so popular that they have ordered a "Directors' Car," to be built by Pullman.

Fig. 29 is a view of the electric street sprinkler, which is rather a new feature in electric railway work. It is used on the suburban roads, where so much dust is raised by the cars going at a high speed and has worked very successfully during the past season. It is equipped with two 30-hp motors, and holds 2,700 gallons of water, and can run 15 miles an hour when sprinkling.

Fig. 30 is a view of one of the six tower wagons used by this company. They were designed by Mr. J. E. Lloyd, the assistant engineer, and consist of a telescoping framework of iron which can be raised by means of a windlass to suit the height of any trolley or guard wire in the city. It is supported on a wagon with a large wheel base which is also supplied with a full complement of tools and materials for making repairs on the lines, in the conduits or on disabled cars, and also carries screw jacks, ropes, etc., to provide for accidents. Fig. 31 is a view of the tower wagon with the platform raised. The design is very ingenious and these tower wagons are probably the most complete in every detail that have ever been constructed. They are kept ready at all times for immediate service, and the company is contemplating the installation of a general alarm and call system extending over all of the lines, by means of which the tower wagons can be summoned by the motor man or conductor without the delay of telephoning. The plan is to place call-boxes at short intervals along the road, which will connect with the main station, the signal being sent there first and then transmitted to the station nearest the trouble.

LOAD DIAGRAM.

The output of station B, 13th & Mt. Vernon streets, for 24 hours, is shown in the diagram, Fig. 32. Readings of the bus-ammeter

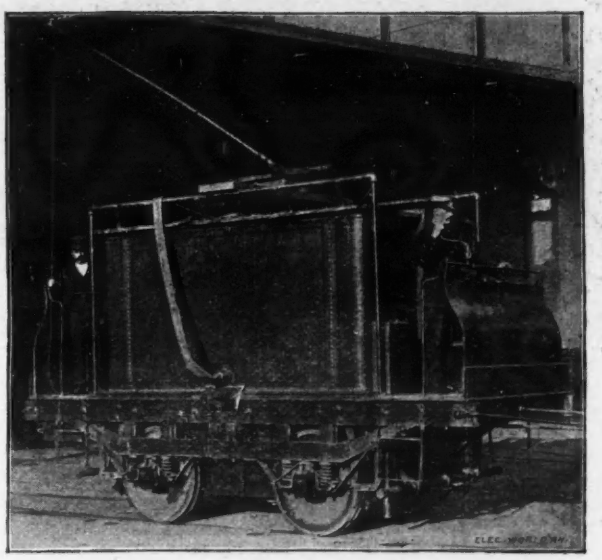


FIG. 29.—ELECTRIC STREET SPRINKLER.

were taken every two minutes and plotted on a time base and an average line drawn. This curve shows the load for a typical day, being neither a very heavy nor a very light one. The continual variations of the current were comparatively small, as they should be in such a large plant, and the variation during the day corresponds closely to the number of cars operated. It has been found that the average current required per car, is about 10 amperes, which is a fair figure considering that the grades are all very small.

The pressure used on the system is about 515 volts, and the larg-

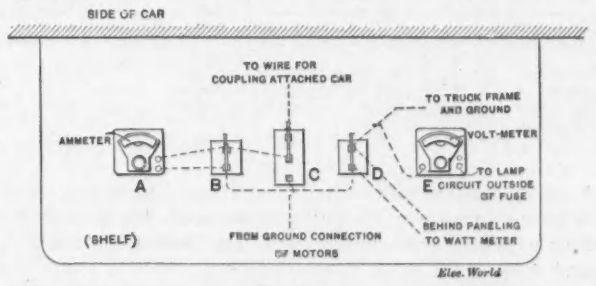



FIG. 28.—ARRANGEMENT OF CIRCUITS IN TEST CAR.

est output up to the present time was about 6,200 amperes for two hours and a half, which is 4,280-hp.

THE ENGINEERING STAFF.

Portraits of the members of the engineering staff are given in Fig. 33, and a brief account follows of their past records and the work they have charge of at present.

Mr. Fritz Uhlenhaut, Jr., Chief Engineer of the Electrical Depart-

ment, is known as an authority upon electric railway work. For several years he has held prominent positions, among which may be mentioned that of Electrician of the Edison Electric Illuminating Company, of Brooklyn, and engineer in charge of construction for the Field Engineering Company, of New York. Mr. Uhlenhaut was born in New York City; he is a graduate of Stevens' Institute of Technology, taking the degree of mechanical engineer in 1888. He is a pioneer in electric railway construction in Philadelphia, having built the first electric road in that city. He now has about one hundred miles of road completed and two hundred and ten miles under his supervision, all of which is the very best that modern practice can suggest and reflects great credit upon him as well as upon his able corps of associates. One of the causes of Mr. Uhlenhaut's success is his executive ability and his policy of dividing the administration of the details of the various departments among a corps of thoroughly capable assistants, who are held responsible for the departments under their supervision. Mr. Uhlenhaut succeeded Mr. F. W. Darlington, who made the original designs of a portion of the system.

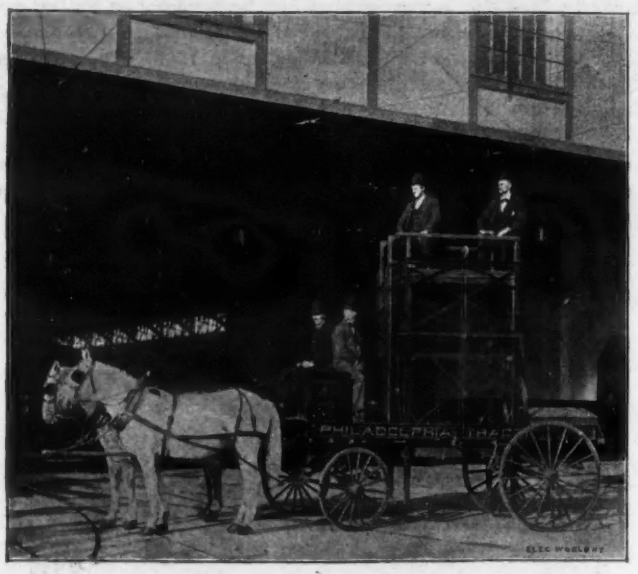


Fig. 30.—Tower Wagon.

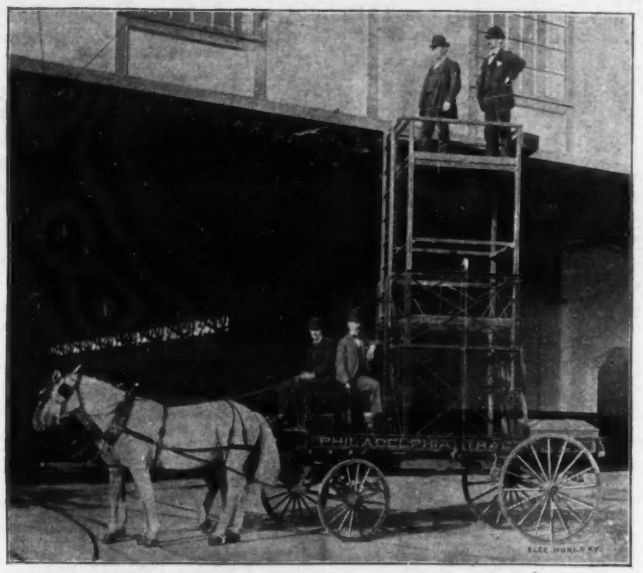


Fig. 31.—Tower Wagon, Platform Raised.

Mr. J. T. Gorman, general superintendent of the Philadelphia Traction Company, which position he has filled since 1881, is well known among street railway companies. He has had a thorough and practical experience in all of the various branches of street-car work prior to his promotion to the position of general superintendent, and is well fitted for the important position which he now fills so well. Mr. Gorman is an "up to date" man, thoroughly posted in modern railway affairs, and the successful operation of this extensive railway system is evidenced by his ability and worth as a general superintendent. His motto is "Keep the cars moving."

Mr. J. E. Lloyd, the assistant engineer, was born in Pittston, Pa., in which city he was brought up with mechanical training. He has held the important position of chief engineer of the Pittston Electric Light and Illuminating Company, and of the Wilkesbarre West Side Electric Railway, and was with the Field Engineering Company when building the Catherine & Bainbridge street railway, which latter he resigned to accept the superintendency of the electrical department of the Buffalo Railway Company. From there he returned to Philadelphia to accept a position with the Philadelphia Traction Company, in June, 1893, as superintendent of the station at Sutherland avenue, and after the completion of the Power Station at 13th and Mt. Vernon streets, he was appointed superintendent of the latter as well as of the lines operated from this plant. Considerng the many cross lines and the intricate switches and cross-overs, the good condition in which these lines are always to be found speaks well for his ability and close attention to their maintenance.

Mr. W. D. Gharky, superintendent of the underground cable department, was born in Ohio and received an ordinary school education in the city of Portsmouth of that state. He took up the study of telegraphy and afterwards became identified with the tele phone service, having, in 1886 and 1887, installed the electrical plant in two of the largest public institutions in his native state. After this he became connected with the Edison United Manufacturing Company, and subsequently with the Edison Electric Illuminating Company, of Brooklyn, in their underground construction department, and was soon promoted to the position of superintendent, having charge of their entire underground system. He resigned this position in 1890 to take a similar one with the Field Engineering Company, of New York, and constructed subway and cable systems for this company in the cities of Detroit and Buffalo. He has the distinction of installing the first underground feeder cable which proved a commercial success in the operation of an electric railway. In August, 1893, he was engaged by the Philadelphia Traction Company and has had charge of their underground feeder system and its construction since that time.

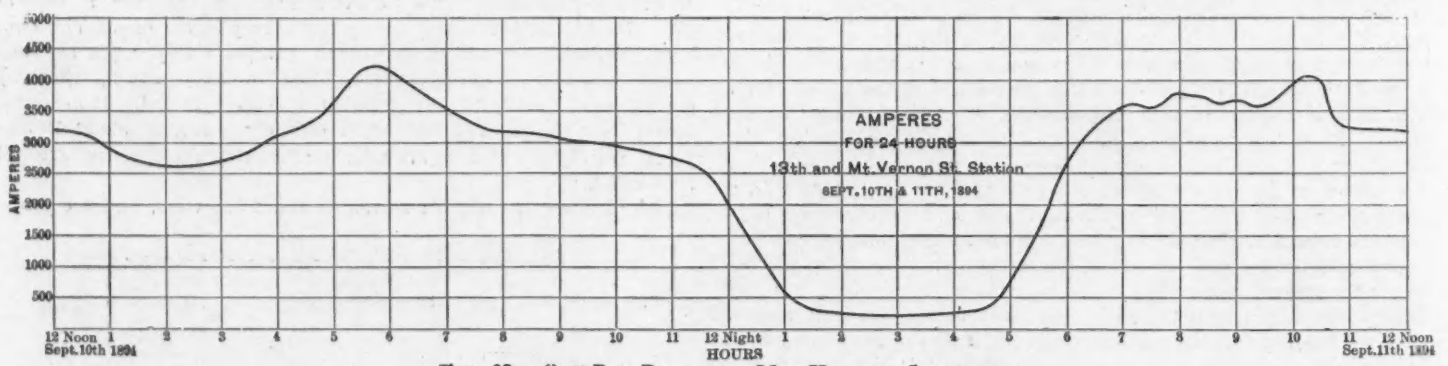



Fig. 32.—Out-Put Diagram, Mt. Vernon Station.

Mr. S. H. Harrington, in charge of the construction department, is a native of Baltimore. Having gone through a mechanical course with the Baltimore & Ohio Railroad Company, he was transferred to the civil engineering department of the same road; the latter position he resigned to take charge of the drawing department of the Pennsylvania Railroad, Southwest system. He left the Pennsylvania Company to accept the position of consulting engineer with the Consolidated Coupler Company and the Gould Coupler Company; later on he was mechanical engineer for the Erie system, and still later held a similar position with the C., C., C. & St. L

Railway, and in May, 1893, entered the services of the Philadelphia Traction Company. His thorough mechanical experience, original ideas and natural inventive genius eminently fitted him for the position which he occupies.

Mr. J. E. Grist, in charge of the steam operating department, was born in Boston, England, and came to this country when a boy. He indentured himself as an apprentice at the works of the B. W. Grist & Company, Ltd., of Reading, Pa., where he served his apprenticeship until the age of 21, and then worked two years as a journeyman, after which he was promoted to foreman of the shop, holding this position for some time; later he was promoted to be superintendent of the Pennsylvania Iron Works Company, in which capacity he remained until January 1st, 1894, when he resigned to open an office as consulting engineer, in the Betz Building, Philadelphia. Soon after, however, Mr. Grist was offered, and accepted, the position which he now holds in connection with the general direction of the machine shop of the company.

Mr. O. W. Durgin, superintendent of subway department, was born in Boston, Mass. His knowledge of subway work has been quite extensive. He was with the Metropolitan Company during 1884 and 1885 and with the New England Telephone Company from for three months and spent one month on the road "installing" for this company.

Mr. R. D. Allen, superintendent of the line construction, was born in Philadelphia. He graduated in 1890 from the Philadelphia Manual Training School, and the following year took the post-graduate course in electrical engineering. He then entered the services of the J. G. Brill & Co. Car Works as superintendent of the electrical department, resigning there in 1893 to take his present position with the Philadelphia Traction Company.

Mr. C. G. Grant, supervisor of track bonding, who is a native of Augusta, Maine, has had considerable experience in his particular line of work and in electrical matters generally, and he entered on his present engagement in May, 1893.

Mr. J. A. Barclay, superintendent of the Sutherland Avenue Power Station, is a native of Greensburg, Ind., and graduated from the University of Nebraska. In 1892 and 1893 he had charge of the electric street railways of Evansville, Ind., and in the latter part of 1893 he entered the service of the Philadelphia Traction Company as assistant superintendent of the Sutherland Avenue Station; in December of the same year he was promoted to superintendent, which place he now holds. Mr. Barclay has a thorough knowledge

PHILADELPHIA TRACTION COMPANY
ELECTRICAL DEPARTMENT.
18 94
TEST CAR "999"
P. UHLENHAUT, JR. CHIEF ENGINEER
J. E. LLOYD. ASS'T CHIEF ENGINEER
W. D. GHARKY UNDER GROUND CABLE DEPT.
J. E. GRIST. OPERATING DEPT.
S. H. HARRINGTON CONSTRUCTION DEPT.
O. W. DURGIN SUBWAY DEPT.
W. I. KIMBALL UNDER GROUND DEPT.
C. G. GRANT. TRACK BONDING DEPT.
15TH & MT. VERNON ST. POWER STATION CAPACITY 9000 H.P.
33RD & MARKET ST. POWER STATION—CAPACITY 25000 H.P.
ELEC. WORLD N.Y.

FIG. 33—PORTRAITS OF THE ENGINEERING STAFF.

1885 to 1893, at which time he was employed by the Philadelphia Traction Company. His experience has admirably fitted him for the respousible position which he has filled during the past eighteen months.

Mr. W. I. Kimball, first assistant in the underground cable department, is a native of Philadelphia. His education was begun in Rugby Academy and finished at Kingston, N. Y., where he graduated in 1889. In March, 1890, he entered the employ of Chadbourne, Hazelton & Co., electric railway contractors, and while with this company he was engaged in the construction of the North Avenue Electric Railway, Baltimore, which was the first electric railway built in that city, and also on the Neversink Mountain Road, Reading, Pa. In October, 1890, he entered the University of Pennsylvania to take the special one year course in electrical engineering, and in the spring of 1892 became associated with the Field Engineering Company, of New York, and was employed in the construction of the Catherine and Bainbridge Streets Railway, the first electric road constructed in Philadelphia. He also worked in the shops of the Westinghouse Electric Manufacturing Company of station work and line maintenance and he has successfully managed the station of which he has charge.

Mr. C. P. Wilson, superintendent 33rd and Market streets Station, was born in Indianopolis, Ind. He completed the Indianapolis High School course in 1888, entered Cornell University and graduated therefrom in 1892 with the degree of mechanical engineer, having given special attention to the electrical course. He subsequently assumed charge of the drawing department of the Indianapolis Training School, but resigned to take a position with the Citizens' Street Railway Company of the same city, remaining with the latter until the acceptance of his present position in April, 1894. The successful operation and orderly appearance of the station under Mr. Wilson's charge is evidence of his ability.

In conclusion the author desires to express his obligation to all the members of the engineering staff for the information concerning this railway system, but especially to the Chief Engineer, Mr. Fritz Uhlenhaut, Jr., and his assistants, Messrs. J. E. Lloyd, Wm. D. Gharky and S. H. Harrington for their invaluable assistance in the preparation of this article.

## Cable vs. Electric Traction.

We recently announced that two of the cable roads of Philadelphia are to be changed to trolley roads, and as we go to press the announcement is made by the Yerkes Chicago Street Railway Syndicate that it has also decided to substitute electric traction on its cable roads.

## Practical Compounding of Dynamos.

BY GEO. T. HANCHETT.

If a shunt machine running at constant speed is required to supply a current to its load-circuit, a certain drop of voltage occurs below that which it gives when running at no load, provided that no rheostat or other means of adjustment have been used to rectify it. This drop of voltage is very nearly directly proportional to the current drawn from the armature, and is due principally to the fact that the extra volts needed to force the increased current through the armature itself are taken from the electromotive force of the machine and apparently disappear from the terminals, and also because the drop of voltage from this cause deprives the magnet of a proportional amount of current and hence weakens it. The armature of the machine loaded with many ampere turns acts as a magnet in opposition to the field magnet, and this tends to weaken the field and hence drops the voltage.

The electromotive force of any one dynamo depends upon two things, namely, its speed and the strength of its magnetic field. These volts thus generated are used for two purposes: First, to force the current through the external circuit; second, to force the current through the armature. Hence we see that if we demand of an armature an increased current we must provide extra volts to drive this current through the armature, if we wish constant potential at the terminals. Since the speed of the dynamo is constant we must therefore increase the strength of the field.

If the armature has re-actions and thus cuts down the field we must provide additional strength to overcome this, also. Knowing the resistance of the armature, it is perfectly possible to calculate the number of extra volts necessary to force any current through it, but it is by no means so easy a matter to calculate the re-active effect of the armature on the field, for this depends on the winding of the armature, the position of the brushes (a variable), the shape of the pole pieces, the quality of the iron and many other considerations.

Many writers have deduced complex formulæ which are supposed to take all these factors into consideration, and at the close of the demonstration say that owing to certain assumptions, which are not exactly in accordance with the conditions of practice, they are only useful in showing the mathematical theory of compounding. If used carefully and intelligently these are of value, but the practical method here described is also useful.

The strength of the magnetic field of a dynamo depends upon the number of ampere-turns surrounding its magnetic circuit. Hence if we wish to increase the strength of the magnetic field, we must increase these ampere-turns. It is obvious that a shunt coil cannot do this, for when unaided the current in it diminishes when the load comes on.

If, however, we have a coil which we can connect in series with the main circuit, it will increase in its magnetizing power as the load comes on. We know how strong the main current will be at full load, but we do not know the additional ampere turns necessary to keep up the voltage. Therefore we cannot compute the number of turns this coil should have. To practically determine the magnetizing power of both shunt and series coils of a compound dynamo, place on the magnetic circuit coils of a known number of turns, all in series. Start the dynamo and separately excite these coils till the machine comes up to voltage. Then draw from the armature the number of amperes which it proposed to use in exciting the shunt field of the completed machine. This is usually two to five per cent. of the full load current. Increase the current in the exciting coils till the machine is again at rated voltage, readjust the current in the armature if necessary, multiply the reading of the ammeter in the exciting circuit by the total number of turns of the exciting coils, and the result will be the proper magnetizing power of the shunt coil in ampere-turns at no load. Continue to increase the current in the armature of the machine till the rated load is attained. Increase the current in the exciting coils till the rated voltage of the machine is reached, being careful to keep the current load the same. This voltage is usually from three to five per cent. more than the voltage at no load, because the machine should be *over-compounded* to make up for the loss in the line. The product of the ammeter reading by the number of turns in the exciting coil, will give the total number of ampere turns necessary, and the difference between this number and the ampere turns necessary for the shunt, plus its increase due to over-compounding, will be the number of ampere turns required for the series coils.

Divide the last named quantity by the rated current of the dynamo and the result will be the number of series turns required. This will be better illustrated by a practical example.

Suppose that we wish to compound a 33-kilowatt Edison shunt dynamo capable of supplying 320 amperes at 105 volts, at 750 revolutions per minute. Suppose that we wish to adjust it for 5 per cent. loss in the line. Suppose that on the field magnet are 3,260 turns, and that at no load a rheostat has to be inserted in series with the fields.

Start the dynamo, separately exciting the field, and allow it to come up to voltage at no load, 105 volts, having an ammeter in the shunt circuit. Suppose this current to be for simplicity's sake 5 amperes. Since in this case we propose to use our "experimental field coil" for the actual shunt field coils in the completed dynamo, we must draw from the armature five amperes, and see if the voltage of the machine is cut down. If this is the case we must mutually adjust current drawn from the armature and exciting current till they are both the same and the voltage of both 105. A good metho in this case is simply to allow the dynamo to excite itself and when the rated voltage is reached take the shunt ammeter reading. Then separately excite and continue. Suppose that this adjustment results in a current of 5.1 amperes. The ampere turns on the magnet are then $5.1 \times 3{,}260 = 16{,}626$. Now increase the main current to full load, 320 amperes. The voltage will drop. Increase the exciting current till the voltage comes up to $105 + 5$ per cent. of $105 = 110.25$ volts, being careful not to let the main current increase while so doing. Now read the ammeter of the exciting coils again, and suppose it now reads 6.3 amperes.

The total ampere-turns are $6.3 \times 3{,}260 = 20{,}538$. From this we must subtract the ampere-turns of the shunt at full load. At full load the shunt supplies five per cent. more ampere-turns than at no load, due to the fact that it is subjected to 5 per cent. more voltage; hence this is $16{,}626 + 5$ per cent. $= 16{,}626 + 831.3 = 17{,}457.3$.

The ampere-turns for the series coils are $20{,}538 - 17{,}457.3 = 3{,}081$. Dividing this by the main current, we have the number of turns required, $\frac{3{,}081}{329} = 10$ turns nearly. We therefore wind five turns on each limb of the magnet and connect them in series.

It is possible to use this method in the case in hand without separate excitation, but for simplicity's sake and also to make the case more general, separate excitation was considered.

As the series coils are simply regulators for the re-actions of the armature and the lost volts consumed in driving the current through the armature, the excellence of the design of a machine is, roughly, nversely proportional to the number of turns on the series coils, for the lost volts and armature re-actions of a good machine are very small.

A machine may be heavily over-compounded or have a number of series bobbins in parallel, and in such a case, when applying this approximation, due allowance must be made.

## Electric Light from Spring Power.

Our contemporary, Lightning, in referring to a recent English advertisement of a dynamo for house lighting, driven by a spring which is wound up, remarks that "the idea of lighting a house by a dynamo driven by clockwork is too delicious to keep to oneself." Although to-day the idea may be ridiculous with electric lights of such poor light efficiency, yet when the generation of cold phosphorescent light by electrical means is an accomplished fact, and from present appearances it may become so before many years, it will not be absurd to talk of generating light for a small house by means of a wound up spring.

## Welsbach vs. Electric Light.

In discussing the Welsbach burner the London *Electrician* remarks that "one of the distinct advantages of electric lighting, which it is impossible to estimate in money value, is the convenience of switching on or off without having to hunt for matches; but with a Welsbach burner a spirit lamp or electric lighter is recommended. The one is, of course, generally empty, and the other almost invariably out of order; but, of course, such trifles are no obstacle to the publishing of startling comparisons between costs of lighting by this bilious looking contrivance and by electric glow lamps."

## Notes on the Management of Railway Power Stations—V.

BY GEORGE T. HANCHETT.

*The Generator.*

The construction of a well made railway generator is such as to enable it to stand a good deal of abuse with regard to sudden changes of load. When one looks at the ammeter of a railway switchboard and sees the needle swinging back and forth some times in sweeps of 150 amperes or more, and knowing that each ampere means nearly a horse power, the severe changes of load are very forcibly called to mind. For the reason that a railway power station often has to bear severe overloads due to disabled machines,

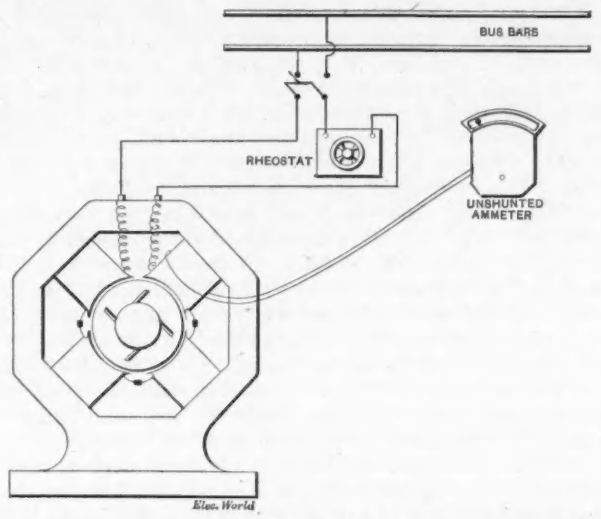



FIG. 15.—METHOD OF DETECTING SHORT CIRCUITS IN FIELDS.

the station engineer should find out by experiment just how much overload each machine can carry at its limit. There will be times when trouble will come and an intimate knowledge of the powers of each machine will be the only means by which the difficulty can be intelligently met.

In the writer's opinion the testing of a generator for overload capacity should be with the idea of developing latent defects. A good railway generator should stand 75 to 100 per cent. overload for an hour at a time. To test a machine for this choose a time when the station load is sufficiently heavy for the purpose, and gradually turn the rheostats of the other machines down till their load comes off them all but twenty to thirty amperes and then throw the double pole switch. Keep the machines turning over at the full voltage ready for instant service. The machine now subjected to the overload should be carefully watched. The station ammeter should be under strict observance and it would be well to have another generator attached to the bus bars. By means of the

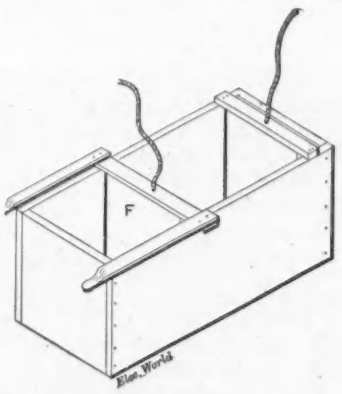



FIG. 16.—WATER RESISTANCE.

rheostats it is possible to keep the load on the machine that is being tested fairly constant.

The eyes, ears and nose should be kept wide open. Ammeter readings should be frequently taken and the behavior of the brushes carefully noted. At the close of the test throw the load on the other machines and shut down. Take the temperatures of the field commutator and armature by placing the bulb of a thermometer upon them and covering the same with a piece of waste. The highest reading should be taken, and should not be over 110 F. above the temperature of the engine room. The load of a station can be made much less trying to the generators if the motormen are carefully instructed. When a circuit breaker is thrown every motor on that line comes to a standstill before the current is thrown on again. On replacing the circuit breaker the heavy starting current of all the motors will probably throw it again, unless, as is too often the case, it is held in by a broomstick. The motormen with odd numbers should be instructed to start first, followed, one or two minutes later, by the even numbers. A defective coil on a generator of the ring or drum type need not necessarily disable a machine. Be sure this coil is open circuited and plug in between the bars to which it is attached with copper wedges. If a mistake is made and a good coil short-circuited, that coil will promptly burn out. A machine will operate for several days with one or more defective coils plugged in this way.

The writer has used the following method of detecting short-circuited or partially short circuited field bobbins. Take the terminals of a Weston station ammeter from its shunt and bring them down by light wires to the machine to be tested. Connect the field magnets of the machine to the bus bars, and with the rheostat choke down the current to a very small amount. Loop a single turn of wire around one of the good field bobbins and connect it onto the terminals of the ammeter and quickly break the field circuit. The ammeter needle will give a sudden kick. Be careful to so connect the ammeter as to have this kick deflect the needle over the scale. Having done this always open the ammeter circuit while you close the field switch. Adjust the current till on breaking circuit a good deflection is obtained. The defective bobbin, on being treated in this way, at once reveals itself by its relatively smaller deflections. (See Fig. 15.) Better results may be obtained by short circuiting all but the bobbin tested and reducing the current in proportion. An ammeter in the field circuit is now necessary to produce comparative results.

The Weston station ammeter deprived of its shunt is a most deli-

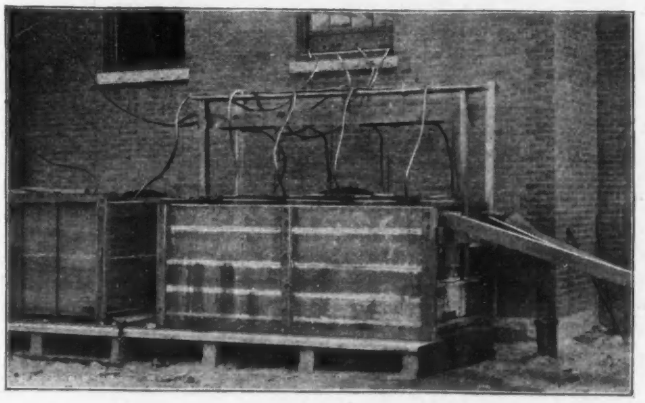


FIG. 17.—A CENTRAL STATION WATER RESISTANCE,

cate detector. The manufacturers state that it will deflect completely across the scale with an E. M. F. of .025 volts. Hence, it is necessary to use the greatest care, as the voltage from an ordinary cell is strong enough to seriously injure it. When well calibrated, it forms a good instrument for investigating leakages, strong field, etc., but unless the operator is well posted as to what he is doing it is best to let it alone.

The writer has produced sensible deflections in the instrument with a single loop of wire and a magnetized knife blade, and standing some twenty feet away from the ammeter. It forms an admirable detector for use instead of the galvanometer described in The Electrical World of February 17, 1894. It is well to shunt it with a light wire when so using it until exact judgments are obtained.

Whenever tests of any nature involving the passage of any independent current through the field coils of a machine have been made, be sure that the polarity of the machine is exactly as it was at first.

The throwing of a machine with a reverse polarity onto the bus bars is the very worst kind of a short circuit, and an armature is sure to burn out somewhere unless the fuse on the machine blows.

Short circuited field bobbins are usually cooler than their fellows. In the armature the exact reverse is the case.

For a commutator compound, the writer has heard of almost every conceivable mixture. Sperm oil gives fair results, and one man has gone so far as to recommend butter applied with a bit of bread. It has been the writer's good fortune to secure good results

with a very little vaseline, applied on a piece of felt. The rule is too little oil rather than too much, but just enough is the best. A carbon brush boiled in vaseline for a few hours will operate in a very satisfactory manner. Such a brush does not have the objectionable property of squealing.

To fit a carbon brush to a commutator, take a piece of sand paper and place it on the commutator, and tie it tightly around with a string. Then spring the brushes down on the sand paper. By means of the rocker handle oscillate the brushes back and forth, and thus grind them to an exact fit. Use different grades of sand paper, finishing with the finest. Trim off the rough edges and soak in vaseline. More trouble airses from incorrect management of brushes than from any other two causes put together. The brushes must be diametrically opposite. They must be at the proper angle. They must be in the proper position. They must have sufficient pressure to prevent sparking and jumping, but no more. Above all, both brushes and commutator should be kept scrupulously clean. At the close of a run the dynamo should at once be put in shape for the next run. It should be inspected and needed repairs or adjustments made. It should be cleaned and new oil supplied if necessary. If these rules are followed out, the station will always be ready to meet any load in the most economical way up to its maximum capacity. Copper and carbon dust is a fruitful source of trouble, which thorough cleaning will obviate.

Feel of the studs and connections; and, if these are hot, take them apart and clean and tighten them.

Do not make the common mistake of having the brushes all in line. The brushes of one holder should be staggered with regard to the next. This will insure even wear of the commutator and will avoid ruts. If the latter do come, remove them with sand paper, not emery cloth. The self-oiling bearings of a new machine must always be regarded with suspicion. Remove the oil from them every day for a week, and renew it. By that time it will be safe to consider that the loose grit has been removed. Inspect the self-oiling rings and be sure they are in motion when the dynamo is running.

A hot box on a dynamo should be treated the same as on the jack shaft or engine. Be careful about the use of ice and water, and keep them away from the armature. If absolutely necessary to shut down, do not shut completely down. Keep the dynamo turning over very slowly to prevent the boxes freezing onto the shaft. When cool, scrape the boxes and repolish the shaft.

Take the speed of the machine after starting. The governor of the engine may be out o adjustment; and, if the speed is right, any undue rise or fall of the potential of the machine cannot be attributed to this cause.

Handle the machine with one hand and stand on the wooden base frame or platform. Disagreeable shocks will thus be avoided.

A most useful adjunct to any station is a water resistance. It willf be found of great value in making tests. It is cheap and it is impossible to burn it out. Fig. 16 shows a very convenient form. By adapting the water with more or less acidulation, the capacity can be varied and to a certain extent the movable plate F will vary the resistance of the apparatus. The practical limit of carrying capacity is reached when the water boils so violently that the current becomes very unsteady.

Fig. 17 shows an actual resistance used in connection with a large central station. It is provided with sources of water supply and drains, and the resistance of the liquid can be quickly varied.

If the field circuit of a machine is suddenly opened the sudden cessation of lines of force within the coils will produce a very high pulse of electromotive force tending to keep the lines there. This force is extremely high; with a 500-volt magnet it mounts up into the thousands. It is, therefore, quite liable to puncture the insulation and is sure to take advantage of any weak spots. Hence it is very desirable to have as little current in a field circuit as possible when breaking it. In testing for short-circuited bobbins, as previously described, it is a good plan to have an incandescent lamp bridging each gap of the double pole switch. This will prevent the circuit from being completely opened, and provide a path for the discharge.

(To be continued.)

## Gas vs. Electricity.

In commenting on this subject the editor of London "Lightning" states: "I need hardly say that any comparison of costs between the two illuminants, is, to my mind, beside the question—it is quite possible that rotten potatoes cost one-tenth less than new ones."

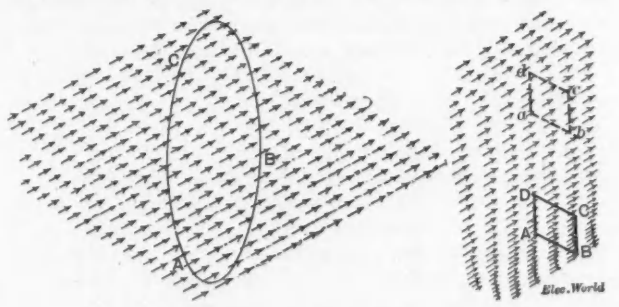
## Electrodynamic Machinery—XV.

BY E. J. HOUSTON AND A. E. KENNELLY.

75. In order that the E. M. F. induced in a wire may establish a current in it, it is necessary that such wire should form a complete curcuit or loop, as indicated in Fig. 55. When such a conducting loop is moved in a magnetic field, some or all portions of the loop will cut flux, and will thereby contribute a certain E. M. F. around the loop. If the loop moves in its own plane in a uniform magnetic flux there will be no resultant E. M. F. generated in it. For example, considering a circular loop, we may compare any pair of diametrically opposite segments, when it is evident that each member of such a pair cuts through the same amount of flux per second, and will, therefore, generate the same amount of E. M. F., but in directions opposite to each other in the loop. At the same time, it is clear that the total of flux in the loop does not change; for, while the flux is being left by the loop at its receding edge, it is entering the loop at the same rate at its advancing edge, and, since these two quantities of flux are equal, the total amount of flux enclosed by the loop remains constant.

76. The cutting of flux by the edges of a moving loop, therefore, resolves itself into the more general condition of enclosing flux in a loop. The value of the E. M. F. induced around the loop does not depend upon the actual quantity of flux enclosed, but on the rate at which the enclosure is being made. If, as we have already shown, the loop is so moved that the total flux it encloses undergoes no variation, the amount entering the loop being balanced by the amount leaving it, although E. M. F.'s will be induced in these parts of the loop both where the flux is entering and where it is leaving, yet these E. M. F.'s being opposite, exactly neutralize each other and leave no resultant E. M. F. Consequently, the value of the E. M. F. induced at any moment in the loop by any motion, does not depend upon the flux density within the loop, but on the rate of change of flux enclosed.

77. If $\Phi$ be the total flux contained within a single loop, such as shown at A, B, C, in Fig. 55, the mean rate at which this flux is changing during any given period of time, will be the quotient of the change in the enclosure, divided by that amount of time, so that if $\Phi$ changes by 20,000 webers in two seconds, the mean rate of change during that time will be 10,000 webers per second, and




FIGS. 55 AND 56.

this will be the E. M. F. in the loop expressed in C. G. S. units. But during these two seconds of time the change may not have been progressing uniformly, and in this case only the average E. M. F. can be stated as being equal to the 10,000 C. G. S. units. Where the change is not uniform, the rate at any moment has to be determined by taking an extremely short interval, so that if $dt$, represents this indefinitely small interval of time and $d\Phi$ the corresponding change in the flux enclosed during that interval, the rate of change will be $\frac{d\Phi}{dt}$ webers per second and this will be the value of the induced E. M. F. at each instant.

78. If a small square loop of wire A B C D, one cm in length of edge, placed at right angles to the flux as shown in Fig. 56, contains a total quantity of flux amounting to 10,000 webers, the mean flux density at the position occupied by the square, will be 10,000 gausses. If now, the loop be moved uniformly upward in its own plane to the position $a\ b\ c\ d$, so as to accomplish the journey in the $\frac{1}{100}$th part of a second, and if the flux enclosed by the loop at the position $a\ b\ c\ d$, be 1,000 webers, then 9,000 webers will have escaped from the loop during the motion. Assuming that the distribution of flux density in the field was such that the emission took place uniformly, the E. M. F. in the loop, during the passage, will have been,

$$\frac{\Delta\Phi}{\Delta t} = \frac{9{,}000}{\frac{1}{100}} = 900{,}000 \text{ C. G. S. units} = 0.009 \text{ volt.}$$

If, however, the rate of emptying, during the motion, were not uniform, 0.009 volt would be the average E. M. F., and not the E. M. F. sustained during the interval, or, in other words, the instantaneous value of the E. M. F. in the loop would vary at different portions of this short interval of time or at corresponding different positions during the journey; but, in all cases, the time integral of the E. M. F. will be equal to the change in $\Phi$. Thus the change in $\Phi$ is, in this case, 9,000 webers. When the motion is made in 1-100th of a second, the E. M. F. is 900,000 C. G. S. units of E. M. F., which, multiplied by the time, (.01 second) gives 9,000 webers. If, however, the motion were uniformly made in half a second, the E. M. F. would have been 18,000 C. G. S. units, which, multiplied by the time, would give as before 9,000 webers; and under whatever circumstances of velocity the change were made, the sum of the products of the instantaneous values of E. M. F. multiplied into the intervals of time during which they existed, would give the total change in flux of 9,000 webers. Or in symbols,

$$\text{Since} \qquad e = \frac{d\,\Phi}{d\,t}$$

$$\int e\,d\,t = \Delta\,\Phi$$

The first equation simply expresses that the E. M. F., $e$, is the instantaneous rate of change in the flux enclosed, and the second equation shows that the difference in the enclosure between any two conditions of the loop is the time integral of the E. M. F., which has been induced in the loop during the change.

79. If a circuit contains more than one loop, as, for example, when composed in whole or in part of a coil, the turns of which are all in series, the E. M. F. induced in any one turn or loop of the coil, may be regarded as being established independently of all the other loops, so that the total E. M. F. in the circuit will be the sum of all the separate E. M. F.'s existing at any instant in the loops, and may, therefore, be regarded as the instantaneous rate of change in the flux linked with the entire circuit. A coil, therefore, may be regarded as a device for increasing the amount of flux magnetically linked with an electric circuit, so that by increasing the number of loops of conductor in the circuit, the value of the induced E. M. F. corresponding to any change in the flux, is proportionally increased, and if the coil or system of loops forming the circuit, contains in the aggregate $\phi$ webers of flux linked with it, taking each turn separately and summing the enclosures, then the time integral of E. M. F. in the circuit will be the total change in $\Phi$, and this will be true, whether the loop is changing its position, or whether the flux is changing in intensity or direction.

(To be continued).

## Practical Notes on Dynamo Calculation—XVI.

BY A. E. WIENER.

PART II.—CALCULATION OF MAGNETIC FLUX.

1.—USEFUL AND TOTAL MAGNETIC FLUX.

*31.—Magnetic Field. Lines of Magnetic Force. Magnetic Flux, Field Intensity.*

The surrounding of a magnetic body, as far as the magnetic effects of the latter extend, is called its "Magnetic field."

According to the modern theory of magnetism, magnetic attractions and repulsions are assumed to take place along certain lines, called "Lines of Magnetic Force;" the magnetic field of a magnet, therefore, is the region traversed by the magnetic lines of force emanating from its poles.

The lines of magnetic force are assumed to pass out from the north pole and back again into the magnet at its south pole; their direction, therefore, indicates the polarity of the magnetic field.

The total number of lines of magnetic force in any magnetic field is termed its "Magnetic Flow," or "Magnetic Flux," and is measured in *webers;* a field of 1,000,000 webers, or one megaweber, for example, is one containing 1,000,000 lines of force.

The intensity of the magnetism at any point within the region of magnetic influence of a magnet, or the Field Intensity of a magnet, is expressed by the number of these magnetic lines of force per unit of field area at that point, measured perpendicularly to their direction.

The Unit of Field Intensity, is 1 line of magnetic force per square centimeter of field area, and has received the name of *gauss.*

A magnet-pole of unit strength is that which exerts unit force upon a second unit pole, placed at unit distance from the former. The lines of force of a single pole, concentrated in one point, are straight lines emanating from this point to all directions, *i. e.*, radii of a sphere. The surface of a sphere of one centimeter radius is $4\pi$ square centimeters; a pole of unit strength, therefore has a magnetic flux of $4\pi$ absolute, or C. G. S. lines of magnetic force, or $4\pi$ webers.

The number of C. G. S. lines of force, or the number of webers expressing the strength of a certain magnetic field, must consequently be divided by $4\pi$, or by 12.5664, in order to give that same field strength in absolute units of magnetism, *i. e.*, in unit-poles.

A magnetic field of unit intensity also exists at the center of curvature of an arc of a circle whose radius is one centimeter and whose length is one centimeter, when a current of one absolute electromagnetic unit of intensity, or of 10 practical electro-magnetic units, that is, of 10 amperes, flows through this arc. Therefore, the unit of magnetic flux, *i. e.*, one C. G. S. line of force, or one weber, is equal to $\frac{10}{4\pi}$ practical electromagnetic units, or one practical electromagnetic unit $= \frac{4\pi}{10}$ webers.

*32.—Useful Flux of Dynamo.*

The total number of lines of force cutting the armature conductors is called the "Useful Flux" of the dynamo.

According to the definition given in Chapter 1, we have:

$$\text{Volts} = \frac{\text{Number of C.G.S. Lines cut per second}}{10^8} \cdots (89)$$

Let now $\Phi$= Total Number of useful lines, or useful flux, in webers;

$K$=Number of conductors all around pole-facing circumference of armature;

$K$=m $\times$ n, for ring-armatures;

$K = 2 \times m \times n$, for drum armatures and for drum wound ring armatures;

(where $m$=Number of commutator divisions,
$n$=Number of turns per commutator division,
$m \times n$= Total number of convolutions of armature; See Chapter 11).

$N$=Speed in revolutions per minute, and

$b$.=Number of bifurcations of current in armature, *i. e.*, number of pairs of armature portions connected in parallel; see Chapters 26 and 27;

then,—

1 *conductor in one revolution cuts* $2\,\Phi$ *lines of force,*

for the $\Phi$ lines emanating from all the north poles, after passing the armature core, return to the south poles, hence pass twice across the air-gaps, and, in consequence, are cut twice in each revolution by every armature conductor.

The armature makes $\frac{N}{60}$ revolutions in one second, hence,

$$1 \textit{ conductor in } 1 \textit{ second cuts } 2\,\Phi \times \frac{N}{60} \textit{ lines.}$$

Each one of the $2b$ parallel armature portions contains $\frac{K}{2\,b}$ conductors connected in series; in each of these $2b$ armature circuits, therefore,

$$\frac{K}{2\,b} \textit{ conductors in } 1 \textit{ second cut } 2\,\Phi \times \frac{N}{60} \times \frac{K}{2\,b} \textit{ lines.}$$

But, according to the law of the divided circuit, the E. M. F. generated in one of the parallel branches is the output voltage of the machine; the E. M. F. generated by any armature consequently, by virtue of (89) is

$$E = \frac{\Phi \times K \times N}{b \times 60 \times 10^8} \text{ volts,} \ldots\ldots\ldots\ldots (90)$$

and from this we obtain the number of useful lines required to produce an E. M. F. of $E$ volts, thus:

$$\Phi = \frac{6 \times b \times E \times 10^9}{K \times N} \ldots\ldots\ldots\ldots (91)$$

For dynamos with but one pair of parallel circuits in the armature, *i.e.*, for bipolar machines and for multipolar dynamos with series connections, we have $b = 1$ (see $b$, chap. 26) and the useful flux for this special case is:

$$\Phi = \frac{6 \times E \times 10^9}{K \times N} \ldots\ldots\ldots\ldots\ldots (92)$$

This is the formula usually given in text books for the useful flux of a dynamo.

(To be continued.)

## The Chinese-Japanese War.

The account of the battle of Yalu from the "Central News" correspondent cost $1,500 to cable; another telegram to the London "Times" must have cost as much.

## Fly-Wheel Accidents.

BY J. J. FLATHER.

In view of the great and increasing number of fly-wheel accidents which have recently occurred, the probable causes referred to by Mr. T. C. Coykendall in your issue of October 13th, are particularly opportune.

In seeking to assign the cause for any accident which may occur we must be prepared to show: First, that the cause can exist in the case in question; second, that it is competent to produce the results ascribed to it, and third, that no other cause can produce these results under the known conditions. The history of fly-wheel accidents during the recent rise and growth of the electric railway has shown that the cause ascribed by Mr. Coykendall may exist, and with the usual construction of fly-wheels it is capable of producing rupture; but it is rarely the case that under the known conditions some other combination of circumstances can not reasonably be said to be the primary cause of the accident. This is evident from the great number of accidents in which it is an open question whether the fly wheel or driven pulley broke first.

Occasionally, however, the rupture of the wheel is directly traceable to the instantaneous hammer-like blows suggested by Mr. Coykendall, which are given to an engine when a short circuit occurs in the line and the circuit breaker is closed by the attendant while the short circuit still exists—instances of which are on record (See "Power," November, 1891, in which this condition of affairs is given as the cause of rupture in a 22-foot fly-wheel at Cincinnati). When a fly-wheel gives way the cause is usually assigned to a defective governor that allows the engine to race, in which case the centrifugal force of the mass in the rim becomes greater than its cohesive strength and the wheel bursts. That wheels do rupture from centrifugal force is indisputable, especially so where the material or method of construction is defective; spongy castings, blow holes, excessive internal strains, weak connecting flanges, bolts too small or too few in number, arms and rim too light, are all causes of weakness which have allowed wheels to go to piece with more or less disaster to life and property, when the speed was augmented somewhat above its normal rate. As an instance of this we would refer to the accident which occurred to the fly-wheel of a Corliss engine at the Charleston Cotton Mills two or three years ago.*

The wheel, which was 20 feet in diameter, had been running as about eighty revolutions per minute, and this speed was not, to alt appearances, increased at the time of the rupture. The circumferential speed was not therefore excessive for a sound wheel, but in this case one segment, which weighed about 1,800 pounds, was badly honeycombed and parted from the rim with great force. The peculiar feature of this accident was that the rest of the wheel maintained its integrity and as the engine was promptly shut down no further damage was done. A new segment was fitted into the rim and the wheel has been running satisfactorily since.

An excellent example of a fly-wheel rupturing under the influence of centrifugal force is furnished by the recent accident at Nashua, N. H., in which the wheel exploded with a violent report followed by a fusilade of shattered rim segments.†

According to "Power" the governor was unharmed and after the accident investigation showed that the pin which secured the small bevel pinion to the upright governor shaft had worked out, allowing the pinion to revolve freely upon the shaft without rotating the governor. The governor was provided with the usual safety stops to prevent the engine taking steam when the balls are away down; but this device was evidently inoperative, from the fact that the engine was running with the stop pin (provided for blocking the governor up when stopping), in position so that the governor could not fall to a plane which would bring the safety stops into action. The wheel was 30 feet in diameter and ran ordinarily at sixty-one revolutions per minute, giving a rim speed of about 5,700 feet per minute. That the wheel attained a high speed before breaking is evident. The looms, which it was driving, threw off, and the engine speeded up rapidly until the rim finally burst. The uniform manner in which it went to pieces was one of the features of the accident and showed that the wheel was well built. The rim flew into a multitude of small pieces and appears to have gone all at once. With one exception all the arms remained perfect and this one was broken near the rim. All of the complete arms retained some portion of the segment flanges, showing that the joint was well proportioned. The quality of the iron as disclosed by the fractures was good, and no indication of weakness appeared in the entire wheel.

*Power, July, '92.
†"American Machinist," Aug. 23, '94; Power, Sept., 1, '94.

That this wheel gave way by reason of excessive speed in the rim can not be questioned, but it is too often the case that centrifugal force is assigned as the primary cause of a fly-wheel accident when the evidence shows conclusively that a sudden shock to the engine was really responsible for the disaster. We have in mind a 30-ton fly-wheel in an iron mill which let go in this way. The fly-wheel was on an engine driving a train of rolls and the roller let his tongs go through the finishing rolls; the sudden shock broke the pillow block bolts and caused the rupture of the entire wheel.*

Another case, previously alluded to, is that which occurred about three years ago in which the fly-wheel of an engine in the power house of the Street Railway Company at Cincinnati, parted with disastrous results. A short circuit had occurred which threw out all the automatic circuit breakers. The switches were manipulated three times, but each time the circuit breakers opened, showing that the short circuit had not been removed. This throwing off and on of the current meant throwing off and on a load of over 700 horse power to the engine. The engineer claims that the speed was no greater than usual, but it is reasonable to suppose that whenever the circuit breakers opened, the speed was accelerated somewhat. The fly-wheel was 22 feet in diameter, and at the rated speed of the engine, sixty-five revolutions per minute, had a rim velocity of 4,500 feet per minute, which might have been exceeded very materially without causing a sound and well-designed wheel to rupture. The accident was doubtless due to the successive shocks incident to the instant application of a load far in excess of that which the engine was intended to carry, and which was thrown upon the wheel when it was presumably running at a higher speed.

As an evidence of the statement that centrifugal force and defective governors are not entirely responsible for fly-wheel accidents, we would point to the fact that heavy fly wheels have been known to go to pieces without making a revolution. Not that there is some mysterious agent at work which is liable to cause an inanimate wheel to fly in pieces at any moment,—although it is well known that wheels have ruptured while at rest,—but this particular wheel we have in mind was a large built up pulley in which the connections were inadequate even for its own weight.

Just after the engine had been started, before a revolution had been made, the lower half of the wheel dropped into the pit, while the upper half, turning sidewise, fell with a crash upon the crank and connecting rod and smashed up the engine.†

In those cases where a wheel cracks or a piece of the rim is broken out without apparent cause, the phenomenon is chargeable to the internal strains in the wheel caused by unequal contraction in the several parts while cooling, which, if it does not rupture the wheel in the mould, may cause a fracture several days afterward.

On this point Mr. Thos. D. West, a well known authority on foundry matters, states that it is practically impossible to cast wheels that will be entirely free from strains.

When a wheel of any description has cast iron arms, rim, and hub all in one piece, there is generally a strain on the arms or rim of the wheel, in extent depending on the proportion of the rim and arms. If the rim is light and the arms heavy, we may look for a cracked rim, caused by the thin rim contracting faster and to a greater extent than the arms. Again, the arms will be the part to crack if the rim be too heavy. In either instance this generally happens while the casting is yet hot and in the sand.

In the case of pulleys having the arms crack after the casting is taken out of the sand, we have a more complicated state of affairs to deal with. In pulleys having heavy arms, compared with the rim, we often see the heavy arms cracked, the light rim remaining whole. In looking at such castings it will be observed that the hub is heavy in proportion to the arms and rim. This hub is the last portion of the pulley to become solid; the rim being light, has become solid, and is already contracting, driving before it the half molten arms into the yet liquid iron in the heavy hub. When the hub solidifies, it contracts, pulling with it the arms, causing a strain, which, when the pulley gets a slight jar, will make the arms crack at the nearest point. The same principle is involved in light-armed pulleys as in heavy ones; that is, as far as the heavy hub is concerned. When there is a heavy hub required it should be cooled as soon as possible by stripping around it, taking out the core, and cooling with water.

Another method is to split the hub either between every arm or every alternate arm which thus allows a greater freedom in contracting. The hub is afterwards ringed with wrought iron or steel bands shrunk on and the openings filled with Babbitt's metal, or wooden strips.

We have alluded to the fact that in a great many cases it is diffi-

*"American Machinist," Mar. 13, '90.
†The "Engineer," 1887.

cult to decide whether the driven pulley or fly-wheel gave way first. From the evidence presented, as far as the facts can be ascertained, it is the opinion of the writer that many accidents are directly chargeable to the driven pulley. In designing pulleys and fly-wheels it is generally assumed that increasing the thickness of the rim does not add to its strength, since the centrifugal force set up in the rim (generally assumed as the cause of rupture) is directly proportional to the weight at the section. This would be true with a solid cylindrical wheel perfectly homogeneous, but since in practice such wheels are seldom employed we must consider the conditions which affect the actual problem.

It has been clearly pointed out by Prof. Unwin, Mr. Stanwood,* and others that the rim is subjected to a bending action between the arms in addition to the centrifugal stress, and should have a certain minimum thickness under varying conditions of velocity, number of arms, diameter of rim and the method of connection in split and segmental pulleys. Split pulleys with thin rims should have double arms along the line of separation since the strength of the pulley is very much reduced if the joint occur midway between two arms. Wide faced pulleys should also have two or more sets of arms that they may the better distribute the pressures and prevent lateral bending. In the same way with segmental wheels, each segment should be bolted at each end to an arm, and with wide faces two or more sets of arms should be used; otherwise a greater thickness is required. It is unquestionably true that many large receiving pulleys are too light in the rim when we consider the hard service now required of them. Even when properly proportioned and of sound iron, the initial stresses set up in the rim and arms in casting are often very great, and if the wheel is not carefully balanced for the speed at which it is to be run, its daily use with the high speeds now common will increase the internal strains so that with a slight increase of speed the danger point is soon reached, as shown in so many cases in which, from the nature of the conditions, the increase in speed could not have been what we would call excessive, showing that a very narrow margin often exists between regular speed and that necessary to burst the wheel.

With thin rims the case is aggravated. If cast so that the thickness of the rim is not uniform, or if the pulley is chucked so that the rim will have an unequal thickness after being turned, the strength to resist rupture will be proportional to its thinnest section, whereas the rupturing force is proportional to its mass. In balancing the pulley a weight is added to the thinner portion, and although the statical balance may be the same as would be produced by uniformly distributing the material over the rim, yet its centrifugal effect when the wheel is at work is concentrated at that part of the rim which is least able to bear the strain, for it is evident that an attached weight can have no effect in resisting the stress in the rim.

Both the centrifugal effect and the bending action between the arms is therefore increased in a greater proportion than the strength due to the section. A heavy rim may not require any more balancing weight than a light one, so that, in proportion to its ability to withstand it, the latter is subjected to a greater stress. Another effect tending to weaken the wheel is a want of symmetry in respect to a plane perpendicular to the shaft. This may follow from the construction or casting of the wheel itself, from the method employed in balancing, or from its being so mounted as not to run true. This feature was very ably discussed by Mr. W. Stuart Smith in The Electrical World, of December 2, 1893. Speaking of this point he says: "If a wheel is mounted so that it does not run true, that is, in such a way that the parts of the rim are forced to revolve in a continually changing plane, a strong gyroscopic action will take place, and strains be set up that are much more severe than those caused by want of symmetry alone, while a combination of the two will produce strains that are beyond the power of ordinary cast iron wheels to stand."

From the foregoing considerations it is not surprising that so many fly-wheels and pulleys have given way of late years, for although the design and construction of such wheels was never better than at the present time it is also true that more severe work is demanded of them.

The bursting of fly-wheels in electric power stations and especially in electric railway stations, where the known conditions would appear to be irreconcilable with known causes, is frequently ascribed to "those nondescript causes that swell the chapter of accidents, from which the carrying on of human affairs appears inseparable."

We have already expressed the opinion that many of these fly-wheel accidents may be due, primarily, to the rupture of the driven pulley. In seeking to assign a cause for this rupture the various elements of weakness in pulleys have been considered, and it has been shown that under suitable conditions a slight increase in stress is often sufficient to fracture the rim or arms of very wide dynamos or jack pulleys with thin rims, which may already be under severe tension due to internal strains.

It is probable that this increase in stress is due to the effects produced by short circuiting, or an overload on the machine. Take, for instance, the case where the line is grounded.

We know that a short circuit in the line increases the load until the circuit breaker acts and relieves the engine; in case the circuit breaker fails to drop, the current is augmented and consequently the load on the machine is greatly increased until the excessive and continued sparking calls attention to the trouble and a switch is thrown if the fuse has not already been blown.

If several dynamos are run in parallel through automatic circuit breakers, and one of the latter fails to respond when a short circuit occurs, the load is thrown upon one machine, which must carry the entire current. A tremendous load is thus imposed upon the machine in either case, and under these conditions the sudden shock, often great enough to throw the belt or stall the engine, may induce sufficient strain to rupture the pulley; if the overload continues and the safety fuse is irresponsive, the slip of the belt increases and under the jerky surging motion it is perhaps thrown off; but if not, the thin pulley rim is quickly heated and the unequal expansion of the rim and arms may be sufficient, under the greatly increased strain due to the belt pull, to rupture a weak pulley, or one badly strained in casting.

An excessive overload, producing shock and heating of the thin rim, may also be responsible for the rupture of jack pulleys which are already strained by various causes close to the safety limit.

When a receiving pulley is thus broken the conditions are often favorable for the fly-wheel to follow. This may happen from various causes dependent upon a sudden shock or increased speed, or most frequently both. Thus in the Pittsburgh accident* that occurred last April in which a 20-foot by 32-inch face fly-wheel weighing 16 tons was fractured, it appears that a short circuit threw a heavy load upon the engine belt which slipped and finally broke the 5-foot jack pulley it was driving. This broken pulley presumably parted the belt, which was drawn toward the wheel with such force as to tear up the flooring and break a 1½-inch governor shaft that extended across the engine, completely stripping all the governor connections from both cylinders. The wheel thus uncontrolled may have attained an excessive speed and ruptured from centrifugal force; but the more probable explanation is that when the jack pulley broke, the belt, which usually ran at 4,700 feet per minute, may have caught and caused a severe shock upon the fly-wheel before it finally was torn apart; this sudden wrench may have been sufficient in itself to rupture the fly-wheel. The manner in which the wheel broke lends credence to the view, as each of the eight arms were fractured at about the same point near the rim, nor were any of the parts thrown to any great distance, as we should expect if the engine had raced. The Brooklyn accident which occurred at the Third Avenue Power Station in October, 1893, was probably another of the many which may be charged to a broken receiving pulley. In this case the fly-wheel was 20 feet in diameter, 52 inches face, and had a rim speed of 5,150 feet per minute. The testimony indicates that there was at first a slowing down of the engine, so great, in fact, that the engineer was afraid the governor balls would descend and cut off the steam supply, so he turned the safety cam in such a way that it would be inoperative.

(To be continued).

*"Trans. A. S. M. E.," Vol. XIV., p. 251.

*"Power," June, 1894.

## Fly Wheel Accidents in Power Houses.

*To the Editor of The Electrical World:*

Sir:—In the communication published in your paper on October 13th, the points to which I wished to draw attention were the following:

1. There have been a number of fly wheel accidents, in which the wheel was of good design and constructed of good material, and in which no speeding of the engine was observed.

2. The closing of the circuit breaker with a short circuit on the line would subject the engine and fly wheel to greater stress than could possibly occur from normal running conditions.

3. An engine and fly wheel, strong enough to withstand all stresses to which it might be subjected under normal running conditions, might still be destroyed by the shock due to an instantaneous load greater than the maximum for which the parts were designed.

It does not appear that due notice has been taken of the fact that destructive effects are due, not to load, but to change of load. In other words, an engine and fly wheel could be made strong enough to withstand safely a given load, and which would still be destroyed by the instantaneous application of that load.

It is assumed by most of the engineers who discuss the problem that rim stress in a fly wheel is due solely to centrifugal force, when it is well known that the bending effect of the arms on the rim gives rise to a resultant stress on the rim which is in the same direction as the resultant, on the rim sections, due to the centrifugal force. This bending stress is enormously increased during change of load, owing to the increased effort of the arms and rim to change their relative positions. This, I believe, is the stress which is most dangerous to fly wheels under the conditions wihch have been discussed. Mr. Abbott appears to have realized the danger due to this cause and to have taken means to prevent it. The lamp circuit spoken of by Mr. Abbott gives undoubted information of a short circuit, but it does not go far enough, in that it gives no information when it is safe to close the circuit until the line resistance rises so high that the lamps are visibly decreased in brilliancy. In the cases of an ordinary circuit the lamps in the cars would form a circuit of sufficiently low resistance to cause the lamps in the tell-tale circuit at the power house to give a brilliant light when the switch was thrown in. Thus the circuit breaker may remain open long after it might be closed with safety, and delay, therefore, may be caused in the operation of the road.

From the correspondence on this subject it is evident that most engineers believe that accidents are mainly due to centrifugal force.

The opinion I desire to express here is that the sudden imposition of load gives rise to the same kind of stress as centrifugal force Therefore an accident may occur from this cause in the same way that it occurs from excessive rim speed.

Rondout, N. Y. T. C. Coykendall.

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*To the Editor of The Electrical World:*

Sir:—The recent articles in your valuable journal from a number of contributors on fly wheel accidents have been exceedingly interesting and full of valuable suggestions. I have been particularly interested in some statements made by Prof. R. H. Thurston. If more detaching gear engines have run away and broken their fly wheels than others, it is most likely because there are more of such engines producing large power than of the non-detaching class, and he himself admits that some accidents have been due to defective fly wheel construction. The reckless use of some manufacturers' names in connection with fly wheel accidents would influence me to avoid mentioning names in an article of this kind if possible. He says that in every case that he has known, the break-down has been of machines of the detachable valve gear class. This statement indicates that he has forgotten or not heard of the accident at Memphis on the McIntosh & Seymour engine, or the one at Sioux City on the Buckeye engine, or another on the same type of engine at Cincinnati, and another which occurred at the World's Fair, Chicago, during the process of construction, on a single valve shaft governor engine, name unknown, and another on a Buckeye engine at Mobile with a throttling governor, or another on an Atlas automatic engine at Muncie, Indiana, and still another on one of the same type at Fostoria, Ohio. I am willing to concede to the manufacturers that in every instance the cause has been due to some condition or circumstance not under the manufacturers' control and for which they should not be held responsible. In the Memphis case the manufacturer clearly proved it to be due to an error in coupling up the parts of the governor, and at least one of the Buckeye accidents was known to be due to a hot eccentric yoke. The detaching valve gear engines being generally large and long stroke, necessarily have large wheels and probably run nearer the danger line than the other class, but a first class fly wheel construction prevents this from being a serious consideration.

It is well known that engineers in electric light stations and railway stations have often taken off the safety stop because of their desire to maintain a record for continuous operation with extreme loads. Probably every detaching valve gear engine in the market to-day has a device simple and effective which will shut down the engine when the governor belt breaks. The first Corliss enigne accident in this city, it is claimed, was due to tying the governor, limiting the travel of the head so that increased speed of the engine did not permit the governor to cut off the steam with the light load following a short circuit. Other cases have been known where the heating of the governor shaft has caused the shaft to stick and the belt to slip upon the pulley, causing the governor to lose speed and causing a rapid acceleration of the enigne.

Why Prof. Thurston should attempt to make a distinction in classes of valve gears for responsibility for these accidents is not clear. So long as automatic mechanism is depended upon, it must have human attention or it will fail and the opportuniites for such a failure are present equally with all types of engines. One fact may be noted, that in most of these wheel accidents the arms have not been first to break; in many cases the arms have been intact and therefore it may be assumed that load strains have not caused the accident. Chas. F. Thompson.

Cincinnati, Ohio.

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*To the Editor of The Electrical World:*

Sir:—The discussion in your columns relative to fly wheel accidents cannot but be productive of good, for it is only by such means that the opinions of different engineers may be collected. It seems to me that, in order to secure immunity from accidents of this nature, the remedy must be such as may be applied to the Corliss engine as it exists to-day, or with very slight modification. That form of engine and valve gear as it now stands is the result of long experience and careful study. To hastily discard that style of governor would be folly. It is equally absurd to look for the speedy relegation to the scrap heap of all cast iron fly wheels. What we need for protection is a sort of "emergency stop" that will not act except in case of excessive speed, and then act wiith certainty.

The suggestion of Mr. G. H. Davis is undoubtedly good, but it is open to the objection that it is complicated, and besides this, it is only useful in electric power and lighting stations. Engine wrecks from this cause are by no means confined to such work, as we have had numerous instances of wheels bursting when driving the practically uniform load of large mills. It seems to me that, whatever the device used, it must, in order to be successful, be applicable to all conditions of load.

Having had considerable experience in the manufacture and installation of passenger and freight elevators, it naturally occurs to me that something analogous to the "governor safety" of such apparatus might be applied with advantage to the Corliss engine. In the most reliable form this consists of a governor similar in form to that of the automatic engine, but much more simple. This so-called governor, instead of controlling the speed of the car, acts only when the speed is approaching the safety limit. The revolving weights being forced outward are made to strike against and trip a stop and so allow the "safeties" to be forced to the guides by the action either of a spirng or the counterweight of the car.

In a similar device, it seems to me, we have a possible solution of the present problem. Such a governor might be placed on the shaft, as suggested by Mr. Davis, and it would then be an exceedingly easy matter to cause it to trip a weight or spring that would close an auxiliary throttle valve in case the speed became excessive.

While this may not be the best solution of the problem in hand, it has the advantages of being simple and sure to act, besides being applicable to any engine now in use.

Boston, Mass. Fred. Brainard Corey.

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## Signalling Through Space.

*To the Editor of The Electrical World:*

Sir:—Believing that your readers are always interested in electrical phenomena, and having noticed from time to time articles bearing upon the subject of "signalling through space," the writer begs to submit the following data concerning an interesting and somewhat exceptional case of telephonic induction.

A trunk line of telegraph wires passes through Mechanicsburg, Pa., from Harrisburg, Pa., to Pittsburg, the distance between the first two stations being eight miles. A short telephone line with earth return runs from Mechanicsburg to a small station about a mile west, parallel to the above trunk line and about 100 feet from it. One calm Sunday afternoon the writer had occasion to transmit two messages over the telegraph line to Harrisburg, whence they were to be sent to Baltimore. After sending both, I casually placed the telephone receiver to my ear and could plainly hear the ticking of telegraphic instruments in the Harrisburg office. To my surprise, I soon heard the Harrisburg operator sending my messages to Baltimore. In this connection it is to be remembered that the Harrisburg—Baltimore line runs due south while the first named trunk line runs due west. The two lines, however, terminate in the same switchboard at Harrisburg. Induction probably takes place from one telegraph line to another and then eight miles away the induced current on the telegraph line influences the short telephone line. E. A. Grissinger.

Pittsburgh, Pa.

# DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

COMPILED FROM PRINCIPAL FOREIGN ELECTRICAL JOURNALS

BY CARL HERING

## ELECTRO-PHYSICS.

*Propagation of Waves in Ice.*—A French Academy paper from "Comptes Rendus," vol. 119, No. 15, by Mr. Blondlot "On the Propagation of Electromagnetic Waves in Ice, and on the Dielectric Power of this Substance," is translated in the Lond. "Elec.," Oct. 19. In a previous paper he enunciated the theorem that the length of the waves is the same whatever the insulating medium, and that it depends only on the dimensions of the oscillator; in the present paper he describes experiments conducted with ice and finds that the theorem is as true for ice as for other dielectrics, and that consequently Maxwell's relation according to which the specific inductive capacity is equal to the square of the index refraction, is true for electro-magnetic undulations through ice. From the experiments he finds that the dielectric power of ice is about 2.

*Origin of Earth Currents.*—Mr. Bachmetjew's paper (see Digest, Oct. 27) is concluded in the "Zeit. feur Elek.," Oct. 15. He discusses the question of how earth currents are produced and describes some tests made with wires on a plane near Sophia; he gives a summary of the opinions of others on this subject, from which he concludes that the cause of such currents must be looked for in the earth or in its atmosphere; he then states that they cannot be caused by the atmosphere and concludes from his experiments that earth currents are produced partially by thermo-electric effects, and partially by electromotive forces generated by the filtration of water through the soil; in certain researches from which he quotes, the E. M. F. generated by pure water filtered through sand in a clear atmosphere, is equal to 6.825 volts.

*Earth Currents.*—"L'Eclairage Elec.," Oct. 6, contains a paper by Mr. Palmieri, describing experiments with earth currents made with a wire from the foot of Mt. Vesuvius part way to its apex; the experiments are to be extended to find the connection between the earth currents and an eruption.

*Atmospheric Electricity.*—According to the Lond. "Elec. Rev.," Oct. 19, Mr. Franklin Fox calls attention to the fact that Saxby claimed electricity to be the cause of all weather; what is wanted is a gauge of the electricity in the air, which could be attached to barometers, which would afford a check on the supposed effects of electricity and which would enable a barometric reading to be made with more insight into its action.

## MAGNETISM.

*Constant-Pull Electromagnet.*—A device by Messrs. Schoeller & Jahr, is described and illustrated in the "Zeit. feur Elek.," Oct. 15. It consists essentially of two magnets, one of which is of the ordinary U type and is pivoted at its neutral point so that its poles move past those of the other magnet which has three poles and cores, the middle pole being of one polarity and the two outside ones of the other, being equivalent to two U shaped magnets with a like pole of each combined to form one pole; the movable magnet is pivoted so as to be capable of moving from a position nearly opposite two of the poles to a position nearly opposite the two others, thus describing a small arc of a circle; it is claimed that the attraction to one side increases at the same rate as the repulsion from the other side diminishes; the commutator enables the current to be reversed in one of the magnets to produce the reverse motion.

*Steel.*—A few values for the magnetic qualities of an exceedingly good dynamo steel made by an English firm, are published in "Ind. & Iron," Oct. 19.

## UNITS, MEASUREMENTS AND INSTRUMENTS.

*Simple Electrical Method for Testing Dynamos and Motors.*—In the Digest, Sept. 8, a method devised by Mr. Lenz was described; in the "Zeit. feur Elek.," Oct. 15, Mr. Grau criticises this method; from this criticism the description of this method becomes more clear and as the previous description was very indistinct, besides containing apparently some typographical errors, it is thought best to give a brief summary of the description as it now appears, in order that the discussion may be more clearly understood. The motor is run unloaded at the required speed and is found to consume $M$ watts; it is then coupled mechanically with any convenient dynamo, which is separately excited with a constant current whose value need not be known, the dynamo being run without a load; from the power then required by the motor deduct $M$, leaving $D$, the power used in the motor to run the dynamo unloaded; $M$ and $D$ may be assumed to be constant; the dynamo is then loaded and delivers at constant speed $W$ watts, including the resistance loss in the armature; the power then consumed by the motor (after subtracting $M$ and $D$) corresponding to this power $W$, is then calculated and represented by $Z$; this latter test is repeated for any desired number of different loads on the dynamo, from full load to nearly no load; if the quotients of $W \div Z$ for the different tests are made ordinates of a curve and the sums of $M + Z + D$ are made the abscisses, it will be found that the curve will be nearly a straight line, especially for small loads; the ordinate for no load on the dynamo may therefore be taken as equal to the quotient of $W \div Z$ for the smallest load, which value of this quotient is represented by $E$; the electrical equivalent of the mechanical power delivered by the motor to the dynamo in the second test (when the dynamo was not loaded) therefore becomes known (as $D$ multiplied by this value of the quotient is this electrical equivalent); the power delivered by the motor for each load on the dynamo will then be $D+E+W$, while that consumed by the motor will be $M+D+Z$, all the quantities being in watts; the efficiency of the motor will then be equal to the former divided by the latter.

In the discussion Mr. Grau claims that there are a number of errors in this method; Mr. Lenz claimed that the Cardew method is based on the incorrect assumption that the efficiency of the machines is the same when used as a generator and when used as a motor; Mr. Grau states that it is well known that the Cardew method is completely independent of this assumption, for if each of the three machines is used once as a motor and then as a generator, the solution of the six equations gives an absolutely correct and reliable result. He states that in Mr. Lenz' method the value of $M$ is assumed as constant, but this he claims is incorrect, as it will change with the load on the motor owing to the short-circuiting of the coils by the brushes, also on account of the reaction of the armature current on the field. The values of the quotients $W \div Z$ are not correct, as they include the factor of the short circuiting of the armature coils by the brushes, the value of $E$ is therefore only approximate. The formula for the efficiency contains the value $D$, which is assumed to be constant, but this, he claims, is not correct, as its value would be a different one when the dynamo is loaded on account of the armature reaction; as these three values which are assumed as being constant, are not so, he believes that this method will not be much more accurate than the dynamometric method, but in all cases much less accurate than the Cardew method. In replying to this Mr. Lenz states that when he spoke of there being no load, he meant it literally and that for no load the value of $M$ is a constant; he claims that in his method the changes in the loss in the motor due to increasing loads, are taken into account, as the curve includes these changes; regarding the value of $E$, he states that the error due to the short circuiting of the coils amounts to only 0.4 per cent. of the total, which may introduce a small error, which, however, is still further reduced by another correction; the value of $E$ may be determined as accurately as one desires by diminishing the current of the dynamo, but as the curve at small load is so nearly parallel the accuracy of the value of $E$ is quite great. Regarding the value of $D$ in the efficiency formula, he replies that its value applies only to no load; the effect of the hysteresis loss is about 1.5 per cent. of that at full load; and the reaction of the armature winding is about 5 per cent. of the action of the field; the hysteresis loss increases more rapidly than the magnetic density and one can assume that the hysteresis loss is diminished by 5 per cent., but even an assumption of 50 per cent. would not be worth considering; the error is diminished by that due to the short circuiting of the coils, so that the mean total error of 0.3 per cent. may occur; a method which is correct to 0.3 per cent. may well be termed a correct and not an incorrect one. (For another method see an abstract under "Dynamos and Motors.")

*Localizing a Fault.*—In the Lond. "Elec. Rev.," Oct. 12, Messrs. Jordan & Schoenau describe a modification of Anderson & Kennelly's method; in the original method a variable resistance is inserted at the end nearest the fault and is varied until the resistances measured from both stations are the same; this involves time and a necessity of speaking between each set of readings, which tends to polarize the fault; to overcome these objections they insert a variable resistance at each of the two ends of the cable, each operator earths alternately for the other, while the other adjusts the resistance so that the total remains the same. They show that the value of the total resistance at which it will be most advisable to commence balancing, is equal to the sum of the resistances measured from each station when the distant end is earthed; this "earth overlap" test can be applied with equal advantage to the "insulation overlap" test.

*Board of Trade Laboratory.*—The article in the Lond. "Elec. Rev.," Oct. 12, is continued in the issue of Oct. 19; the ground plan of the

laboratory and the current and pressure standards, already mentioned before in the Digest, are described and illustrated.

*Magnetic Testing Machine.*—The apparatus described in the Digest, Aug. 18 (see also Sept. 15), is described and illustrated in the Lond. "Elec.," Oct. 19.

*Testing Set.*—A brief illustrated description of the Turvey set, consisting of a resistance box and galvanometer, is published in the Lond. "Elec. Eng.," Oct. 19.

## DYNAMOS AND MOTORS.

*Calculating the Current for Continuous Current Motors.*—In the "Elek. Zeit.," Oct. 18, Mr. Mueller states that as the determination of the efficiency of a motor by means of a Prony brake requires considerable time and is rather expensive for large motors, he proposes the following indirect method to determine the mechanical output of a motor. Let the motor be run unloaded and the voltage be regulated so that it will run at its required speed, then measure the voltage and current; from the product deduct the resistance loss in the armature and the result will be the power required for running unloaded, representing the hysteresis and Foucault current losses, the bearing and air friction; the horse power delivered, at any desired load, is then equal to the watts delivered to the motor, less the resistance loss in the armature, less the above mentioned quantity, and the whole divided by 746; from the equation thus formed he deduces (from the quadratic equation) the value of the current and finds it equal to the following:

$$C = \frac{e - \sqrt{e^2 - 4R\,(\text{hp} \times 746 + W)}}{2R}$$

in which $e$ is the voltage at the terminals of the motor, $R$ the resistance of the armature with brushes and connections, and $W$ the power at no load above referred to. This formula is for shunt motors; if it is a series motor the combined resistance of the field and armature must be substituted for the armature resistance; the use of the formula is illustrated by an example. Experiments have shown that by this method more reliable results can be obtained than by the use of the Prony brake and it requires only a single person to make the test, while the other requires three persons. In an editorial discussion it is stated that this method for determining the efficiency, which is also applicable to generators, has the advantage that it is a rapid method and can be carried out at but slight expense; it has frequently been used by others but may not be generally known; it is, however, not as accurate as might be desired; the assumption that the hysteresis and Foucault losses are the same when loaded as when unloaded, is not correct, for in general both losses will increase with the load, especially the Foucault current losses; it should also be noticed whether the armature is a ring or a drum, as in the former the increase of these losses is greater; another reason why it is inaccurate in machines driven by belts lies in the fact that the bearing friction will increase with the tension on the belt, so that the efficiency according to this method will be higher than the true result, but in all cases where great accuracy is not necessary, this method can be used to advantage. (For another method for determining the efficiency see an abstract under "Measurements.")

*Alternate Current Motors.*—A patent of Hutin & Leblanc for the production and maintenance of synchronism is described and illustrated in the "Elek. Anz.," Oct. 14.

## ARC AND INCANDESCENT LIGHTS.

*Holophane Globes.*—"L'Ind. Elec.," Oct. 10, contains a description at some length, by Mr. Claude, of the diffusing globe called "holophane" invented by Messrs. Blondel & Psaroudaki. This is said to be a truly scientific solution of the problem of proper diffusion of the arc or other light, the results being quite remarkable; the object is to diffuse the light by total reflection and refraction in a globe of perfectly transparent glass; these globes are made with vertical corrugations on the inside surface and horizontal corrugations on the outside surface and are formed of pressed glass; —the interior corrugations diffuse the light horizontally and the exterior ones diffuse it vertically. The theory is discussed at some length and it is shown that the corrugations must be determined very carefully in order to avoid the internal reflection from the glass, most of which would represent a loss similar to the absorption of an opal globe; for interior lighting, where a general diffusion is required, the corrugations are all similar, but for street lighting they are so proportioned that all points on a horizontal plane below the globe, are uniformly illuminated up to an inclination of 15° below the horizon (in this connection attention is called to the curve shown in the Digest, Aug. 11); this is caused partially by a total reflection of the rays which originally pass above the horizon of the lamp; such a globe appears from a distance like a ball of uniform brightness all over. The results were confirmed by some tests with a globe 15 in. in diameter around an arc lamp, the curves of illumination of which, with and without the globe, are given; the former is such that the light on the horizontal plane below the lamp is nearly uniform for a radius equal to about three times the height of the lamp; the absorption was in one case found to be 13 per cent. and in another, 9 per cent., which corresponds to about the absorption in transparent glass, showing that the diffusion is obtained without loss; in addition to this there is a slight irridescence to the light which gives it a peculiarly rich appearance; he believes this solves the problem of interior illumination with arc lights.

*Projectors.*—The first part of a long serial by Messrs. Tchikoleff & Turin is concluded in "L'Eclairage Elec.," Oct. 6; it treats of the relative visibility of the illuminated objects. The second part of this treatise will be published in the near future.

*Diminishing the Consumption of Arc Light Carbons.*— A translated description of the device of Mr. Jehl, abstracted in the Digest last week, is published in the Lond. "Elec.," Oct. 19, with the illustration.

*Filaments.*—According to "L'Eclairage Elec.," Oct. 6, Mr. Baum increases the refractory power of the filaments by treating the organic fibres with phosphate of ammonia, chlorohydrate of ammonia, chlorate of calcium and chlorate of magnesia; they are then exposed to a high temperature to volatilize the ammonia salts, forming a porous phosphate of calcium and magnesia; they are then treated with a dilute solution of gelatine and carbonate of calcium.

*Telescopic Suspension.*—An arrangement for chandeliers and suspended electric lights, is described and illustrated in the "Elek. Tech.," Oct. 15.

## ELECTRIC RAILWAYS.

*Working Expenses of Railways.*—The article begun in the Lond. "Elec. Rev.," Sept. 7 (see Digest, Sept. 29), is continued in the issue of Oct. 19. Similar tables are given for the Birmingham and Edinburgh cable lines, the only two in Great Britain for which the data is available. In conclusion it is stated that from the figures given it appears that electric traction for short local lines, where the traffic is sufficient, can compete favorably with steam locomotives, "while in the case of street tramways it will be difficult to find any method of haulage which, with a fair traffic can be operated more economically than the cable system."

*High Speed and Power of Locomotives.*—The paper from the French by du Bousquet, mentioned several times before in the Digest, is abstracted in the "Foreign Abstracts" of the Institution of Civil Engineers, vol. 118, part 4, in which the tables of results are given; they include the resistance per train ton for various speeds and grades, also the power required to move one ton at different speeds and grades; another table gives the weight of locomotive for a number of different speeds (although referring to steam locomotives some of the results are applicable also to electrical high speed traction).

*Mechanical Traction for Street Railways.*—The translation of the paper by Mr. Marchena, mentioned in the Digest, Oct. 6, is continued in the Lond. "Elec.," Oct. 19; some tabulated data is given for the efficiency of three motors variously connected for different grades and speeds.

*Underground Conduit Road.*—An improvement recently made in Europe, of the Love conduit system, is briefly but very indistinctly described in the "Elek. Tech.," Oct. 15; it is said to have been tried and to have shown itself to be a very important improvement.

## CENTRAL STATIONS, PLANTS, SYSTEMS AND APPLIANCES.

*Phase Regulation.*—In a communication to the "Elek. Zeit.," Oct. 18, Mr. Arnold, in referring to the suggestion of Mr. Imhoff (see Digest, Oct. 13) to use the exciter as a phase regulator, states that this idea would not be applicable in any case; with a simple calculation he shows that the capacity of the exciter in cases in which phase regulation is necessary, will be far below the required capacity; he calculates the results for a case in which the phase difference is 45°, in which case the capacity of the extra dynamo (which is connected in parallel with the generator) to generate the wattless current, will be equal to that of the generator; for smaller values of the angle of lag than that for which the cosine is equal to 0.95, phase regulation will hardly be necessary, but even in this case the capacity of the extra generator would still be 32.6 per cent. of that of the main generator, from which it is seen that the capacity of the exciter is far too small; he also intimates that there are other reasons why such an application of the exciter in installations would not be practicable. He shows the importance of the use of an extra generator in that it has a favorable effect on the proportioning of the main generator; by calculation he demonstrates that if such an extra generator is used, the main generator can be proportioned considerably smaller; it is not necessary, however, that the shifting of the phase in the generator need be neutralized entirely, as it is sufficient in many cases that the extra dynamo supplies only a part of the magnetization current; this is the case in the installation mentioned in the Digest, Oct. 27; in conclusion he states that the phase indicators of Dobrowolsky are very useful instruments for the regulation of the phase difference.

*Three-wire System.*—In the recently published article by Mr. Claude, abstracted in the Digest, June 23 and July 7, he recommends replacing the three-wire system by a two-wire system in which two lamps are always connected in series. A further discussion of the system is contained in "L'Eclairage Elec.," Oct. 6, and translated in the Lond. "Elec. Eng.," Oct. 19. Mr. Vitte approves of the system, which appears to be in use in a station in Lyons and recommends that in the exceptional case where only one lamp is to be used, lamps of 200 volts could be employed or else two lamps of half the candle-power can be placed in series; he thinks the system has very great advantages. One

of the advantages stated by Mr. Claude is that it enables the lamps to be forced to 2.5 watts per candle.

*Melbourne.*—A description of the central station is published in "Ind. & Iron.," Oct. 19.

*Electrical Speed Indicator.*—The Spratt indicator is illustrated and described in detail in the Lond. "Elec. Rev." Oct. 19; an electrical circuit is closed periodically through a brush and a segment on the shaft, and this operates a somewhat complicated mechanism on the indicator; the indicator contains a button which must be pressed for exactly fifteen seconds, during which time the number of contacts made, reduced to revolutions per minute, will appear in figures on an annunciator dial.

*Lightning Arresters.*—In an article of some length begun in the "Elek Echo.," Oct. 20, Dr. Denzler gives a descriptive summary of lightning arresters for lighting and power circuit, accompanied by diagrams.

## TELEGRAPHY, TELEPHONY AND SIGNALS.

*Subscribers' Telephones without Batteries*—The Merino system in which the batteries are at the central station instead of at the subscriber's end, described in the Digest, Aug. 4, is described with illustrations in "L'Eclairage. Elec.," Oct. 6.

*Induction in Telephone Circuits.*—A recent paper by Mr Muench, of the German Telegraph Department, is reprinted in part in the "Zeit. feur Elek.," Oct. 15.

*Minimum Current in a Telephone.*—Lord Rayleigh's paper, abstracted in the Digest, Oct. 6, is published in part in the Lond. "Elec.," Oct. 19.

*Telegraph Statistics.*—According to the Lond. "Elec.," Oct. 19, the total number of telegrams transmitted in the United Kingdom in 1892 was about 70,000,000; in the United States 62,000,000; in France 32,000,000; in Germany 31,000,000; in Austria 11,000,000 and in Italy 8,000,000.

*Bells with Different Sounds.*—A device by Mr. Neuman is described in the "Elek. Tech.," Oct. 15; the single bell is replaced by two concentric bells of different musical notes, each having its own clapper, thus enabling two different signals to be given, while a third different signal is produced by pressing both buttons and ringing both bells together.

*Clocks.*—The apparatus for clocks driven by an alternating current is illustrated and described in the "Elek. Anz.," Oct. 18.

## ELECTRO-CHEMISTRY.

*Electric Energy from Combustion of Coal.*—An editorial in the "Elek. Zeit.," Oct. 11, reviews a recent paper by Dr. Borchers a full report of which is promised in the next issue. He gives the results of experiments for transforming the chemical energy into electrical energy by the oxidation of combustible material; although conducted on a small scale they show that it is quite possible to do this; currents up to ½ ampere were obtained by the combustion of carbonous oxide into carbonic oxide, the two electrodes, copper and carbon, not being consumed; in another test, fine coal dust was used instead of gas, but it has the disadvantage that the electrolyte must be changed frequently on account of impurities; when Dowson, or a similar gas, was used, the action appears to have been increased.

*Accumulator Bolt*—A bolt is described and illustrated in "Cosmos," Oct. 20, in which the nuts are formed of caps completely covering the ends of the bolt with the intention of completely covering the thread so as to protect it from the action of the acid.

*Chemical Theory of Accumulators.*—Mr. Wade's article is continued in the Lond. "Elec.," Oct. 19; he discusses the more purely chemical aspect of the discharge phenomenon.

## MISCELLANEOUS.

*Application of Motors.*—The article mentioned in the Digest, Oct. 27, is continued in the Lond. "Elec Rev.," Oct. 12. Several motors are described and illustrated; an illustrated description is given of the Baynes automatic starter for motors, in which an acid resistance and a damper are used and in which 30 seconds are required to put the full power on the motor; wherever sudden loads are thrown on the motor he insists upon using fly-wheels on the motors; the application of electricity in mines is also discussed; among the results of the tests it is stated that with a 42-inch band saw with 4 ft. per minute feed, the cost of cutting oak was .3 cents per foot (presumably for the current only); the cost of cutting deal with a 30-inch circular saw and a feed of 13.3 ft. per second, the peripheral speed of the saw being 10,895 ft. per minute, was 0.18 cts. per foot; an elevator running at 80 ft. per minute with a full load of one ton costs one cent per trip at 12 cts. per kilowatt-hour; a chopping machine cost 0.4 cts. per pound of meat when chopping 110 pounds.

*Launches.*—An illustrated description of several recently constructed launches is given in the "Elek. Anz.," Oct. 14.

*Coal Cutting Machines.*—In the conclusion of the long serial by Mr. Snell on "Electric Motive Power" in the Lond. "Elec." Oct. 19, he describes and illustrates some coal cutting machines.

*Submarine Detector.*—The M'Evoy detector is described in several of the London journals for Oct. 19. A description was published in the Electrical World last week.

*Concentration of Sulphuric Acid.*—An abstract from an article in the "Chemiker Zeitung," is published in "L'Elec.," Oct. 6; it states that 32,671 calories, corresponding to 51.3-hp hours, or with radiation to 60-hp hours, are required to concentrate 117-kg at 60° concentration to 100-kg at 66°; whether it would be cheaper to do this by electricity depends on the cost of the current.

*Dermatines.*—A description of this material is given in the "Elek. Tech.," Oct. 15; it is a material belonging to the same class as India rubber, but is prepared differently, carbonate of magnesia being used "for compensating the sulphur for vulcanization;" it is said that it resists all atmospheric influence and does not become brittle with time, as is the case with India rubber, in which the acid produced by the sulphur is not neutralized; the material is not vulcanized, but is aged by a different process; in dissolving, no materials like benzine, naphtha, etc., are used, which, in the ordinary rubber involves a subsequent oxidation process; the process is that of Mr. Zingler in England.

*Extraction of Teeth.*—According to "La Nature," Oct. 13, a London dentist extracts teeth by connecting the two hands of the patient with the poles of a Ruhmkorff coil having a very fine wire secondary and an interrupter making 452 vibrations a second; the current is increased to as much as the patient can stand and the extracting tongs are then "put into circuit" and placed on the tooth, which, "under the action of the vibrations," is easily extracted; no other sensation is said to be experienced than that of the current.

*Municipal Central Stations.*—An editorial in the "Elek. Zeit.," Oct. 18, criticises a recent statement in a German paper to the effect that from a commercial standpoint municipal stations are not to be recommended; the editorial claims that had the deductions been made from German stations the results would have been different; as it is, they were based largely on English and American stations, in which the conditions are quite different from those in the average German station; from a table of data published in the same number, giving the net profit and the interest which it represents, it appears that these well designed and well conducted German stations not only give satisfactory results from an engineering standpoint, but also from a commercial one. The same article is also discussed at some length in the "Elek. Anz.," Oct. 18.

*Educational.*—A description of the course and the laboratory of the school at Chemnitz is given in some detail in the "Elek. Echo," Oct. 20.

*Biographical.*—The "Elek. Zeit.," Oct. 18, publishes a recent paper by Dr. Ostwald on "Johann Wilhelm Ritter, the Founder of Scientific Electro-Chemistry;" his researches were made almost a century ago.

*Abstracts.*—The "Foreign Abstracts" of the Institution of Civil Engineers, vol. 118, part 4, contains a large number of abstracts of recent electrical papers; with the exception of those appearing originally in American papers, they have all been abstracted in the Digest, though not to such length as they appear in that publication.

## Moonlight Tables for December, 1894.

Herewith we give Mr. H. W. Frund's tables of lighting hours for the month of December under his modified form of moonlight schedule.

TABLE NO. 1.
Standard Moonlight System.

| Date. | Light. | Date. | Exting. |
|---|---|---|---|
| 1 | 7.10 P. M. | 2 | 6.10 A. M. |
| 2 | 8.20 " | 3 | 6.10 " |
| 3 | 9.20 " | 4 | 6.10 " |
| 4 | 10.20 " | 5 | 6.10 " |
| 5 | 11.20 " | 6 | 6.10 " |
| 6 | | | |
| 7 | 12.20 A. M. | 7 | 6.10 A. M. |
| 8 | 1.30 " | 8 | 6.10 " |
| 9 | 2.30 " | 9 | 6.10 " |
| 10 | 3.40 " | 10 | 6.10 " |
| 11 | No light. | 11 | No light. |
| 12 | " | 12 | " |
| 13 | 5.00 P. M. | 13 | 6.20 P. M. |
| 14 | 5.00 " | 14 | 7.40 " |
| 15 | 5.00 " | 15 | 9.00 " |
| 16 | 5.00 " | 16 | 10.10 " |
| 17 | 5.00 " | 17 | 11.30 " |
| 18 | 5.00 " | 19 | 12.40 A. M. |
| 19 | 5.00 " | 20 | 1.50 " |
| 20 | 5.10 " | 21 | 2.50 " |
| 21 | 5.10 " | 22 | 4.00 " |
| 22 | 5.10 " | 23 | 5.10 " |
| 23 | 5.10 " | 24 | 6.20 " |
| 24 | 5.10 " | 25 | 6.20 " |
| 25 | 5.10 " | 26 | 6.20 " |
| 26 | 5.10 " | 27 | 6.20 " |
| 27 | 5.10 " | 28 | 6.20 " |
| 28 | 5.10 " | 29 | 6.20 " |
| 29 | 5.10 " | 30 | 6.20 " |
| 30 | 5.10 " | 31 | 6.20 " |
| 31 | 8.10 " | 1 | 6.20 " |

Total No. of hours, 245.10.

TABLE NO. 2.
Frund's New Moonlight System.

| Date. | Light. | Date. | Exting. |
|---|---|---|---|
| 1 | 5.00 P. M. | 2 | 6.10 A. M. |
| 2 | 5.00 " | 3 | 6.10 " |
| 3 | 5.00 " | 4 | 6.10 " |
| 4 | 5.00 " | 5 | 6.10 " |
| 5 | 5.00 " | 6 | 6.10 " |
| 6 | 5.00 " | 7 | 6.10 " |
| 7 | 5.00 " | 7 | 12.00 M. |
| 8 | 1.30 A. M. | 8 | 6.10 A. M. |
| 8 | 5.00 P. M. | 8 | 12.00 M. |
| 9 | 5.00 " | 9 | " |
| 10 | 5.00 " | 10 | " |
| 11 | 5.00 " | 11 | " |
| 12 | 5.00 " | 12 | " |
| 13 | 5.00 " | 13 | " |
| 14 | 5.00 " | 14 | " |
| 15 | 5.00 " | 15 | " |
| 16 | 5.00 " | 16 | " |
| 17 | 5.00 " | 17 | " |
| 18 | 5.00 " | 19 | 12.40 A. M. |
| 19 | 5.00 " | 20 | 1.50 " |
| 20 | 5.00 " | 21 | 2.50 " |
| 21 | 5.10 " | 22 | 4.00 " |
| 22 | 5.10 " | 23 | 5.10 " |
| 23 | 5.10 " | 24 | 6.20 " |
| 24 | 5.10 " | 25 | 6.20 " |
| 25 | 5.10 " | 26 | 6.20 " |
| 26 | 5.10 " | 27 | 6.20 " |
| 27 | 5.10 " | 28 | 6.20 " |
| 28 | 5.10 " | 29 | 6.20 " |
| 29 | 5.10 " | 30 | 6.20 " |
| 30 | 5.10 " | 31 | 6.20 " |
| 31 | 5.10 " | 1 | 6.20 " |

NOTE.—These schedules are made up on sun time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made to all the times here given.

## New Books.

CENTRAL STATION BOOKING AND SUGGESTED FORMS. With an Appendix for Street Railways. By Horatio A. Foster. New York: The W. J. Johnston Co., Ltd. Cloth. 140 pages. Price, $2.50.

Mr. Foster rendered substantial aid to the electrical industry when he published about three years ago a little book of fifty pages on "Central Station Management and Finance." Since the issue of the former book, Mr. Foster has critically examined, as agent of the United States Census, a large number of electrical stations, and as a result of that experience and further study he offers the present treatise as an improvement upon and extension of his earlier work.

The book contains a classification and analysis of the various accounts that are likely to be required in the business management of an electric light or power station. In addition to this system of bookkeeping, which constitutes Part I, Part II is devoted to a number of suggested forms for reports of engineers, inspectors, linemen and other employés, requisitions, orders and similar blanks.

The book thus contains a very complete and systematic scheme of accounting and general management, which, as stated by its author, need not be adopted bodily, but will serve as a basis and may be modified to suit any particular case. In fact, no one organization is ever likely to require all the accounts, reports, etc., that are given, but the officers of each company can readily leave out or combine accounts or blanks, according to circumstances. The various accounts are arranged in five general classes, viz.: Operating expenses, income, profit and loss, property and resources and liabilities. The first class, operating expense, is divided into three parts, manufacturing, distribution and general expense, and each of these comprises seven or eight items, such as repairs, labor, fuel, etc. It is to the operating expenses that particular attention is given for the reason that these accounts are most important in guiding and improving the management and economy of a station. Nevertheless, these very accounts are usually kept less accurately and less intelligibly than any of the others, and it is rare to find a station in which the costs of production are definitely known. The numerous losses and leaks that may exist in the operating expenses necessitates a very careful sub-division and scrutiny of these accounts in order that any fault may be promptly detected and rectified.

Mr. Foster points out that in larger stations an immense amount of writing and danger of error may be avoided by adopting the voucher system instead of keeping a ledger account with each individual creditor. This applies to small accounts, but if many purchases are made during a month, or there is trading back and forth, it would then be more convenient to keep a special account in the usual way.

In the voucher system all invoices, after approval for quantity, prices, etc., by the proper authorities, are credited to an account called "Audited Vouchers," which may include many small creditors and thus greatly reduce the number of ledger accounts. There is little to find fault with in the text or making of the book, except that a number of sample headings for ledgers, registers, etc., are folded into it, and since they are full size, they are in many cases very clumsy. For example, Form No. 56, for "Meter Customer's Register," adds fourteen thicknesses of paper to the bulk of the book, which might easily be reduced to five if the last ten months of the year were omitted, they being precisely similar to January and February, and might safely be left to the reader's imagination. This difficulty is trifling, however, and can easily be overcome by cutting out the superfluous paper.

The book as a whole is clear and thorough, and should be gratefully received by electrical engineers and business men.

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY. Fifth Year of Publication. The W. J. Johnston Company, Ltd. 760 pages. Price, $5.00.

While it is, of course, well-known that the capital invested in the electrical industry is enormous, and that central station lighting, electric street railway traction, isolated incandescent lighting and the supply business connected with these have taken on huge proportions, yet it is doubtful if the actual extent they have reached is fully realized. These facts, however, are very forcibly presented by a glance through the pages of Johnston's Electrical and Street Railway Directory, the 1894 edition of which has just appeared from the press.

That an industry which came into existence but little over a decade ago should now require a directory of no less than 741 octavo pages furnishes in itself a significant indication of unparalleled growth, which is accented when we come to consider the numerical side of the subject.

In the arrangement twelve departments or divisions have been made, as follows: Central Stations: Prices Paid for City Lighting; Isolated Electric Plants; Electric Mining Plants; Street Railways; Telephone Companies; Telegraph Companies; District Messenger Companies; Electrical Associations, Societies, etc.; General Electrical Trades, arranged both geographically and by trades and, finally, in an Alphabetical Finding List.

Under the first of these heads—Central Electric Light Stations—we find enumerated 2,344 different plants in the United States, Canada, Mexico and Cuba, with an aggregate paid in capital stock of $277,437,113, the plants being distributed as follows: United States, 12,124; Canada, 172; Mexico, 41; Cuba, 7.

The 965 street railways enumerated aggregate the enormous sum of $648,330,755 capital invested. This sum is divided among the various systems as follows: 606 electric railways, $423,493,219; 359 horse, steam and cable railways, $224,837,536. The remarkable growth in electric railways is indicated by the fact that in 1889 there were only 200 miles of such road, which, in 1891, had increased to 2,250 miles, and in three years more to 7,470 miles.

Information relating to about 7,500 isolated electric light and 275 mining plants is given in their respective departments, and in another have been collected the prices paid for city lighting, which are given for 353 cities and towns in the United States and Canada.

The names and addresses of 5,444 manufacturers, dealers, electricians, etc., are arranged in three lists—in one geographically according to cities and towns, in another according to lines of business and alphabetically in a third or finding list.

It is interesting to note the distribution of manufacturing and commercial firms connected with the electrical industries; New York, Pennslyvania, and Massachusetts lead with 1,219, 682 and 627 firms respectively; next in order are Illinois with 535, Ohio with 355, and New Jersey with 218; the other states having more than 100, but less than 200 firms, are Connecticut, Michigan, Missouri, California and Indiana.

A feature that will be appreciated by electrical supply and other dealers is the information given in regard to the size of plants, type of lamps, cars and other apparatus used, and the names of managing officials and purchasing agents.

ELECTRICITY, ELECTROMETER, MAGNETISM, AND ELECTROLYSIS. By G. Chrystal, M. A., LL. D., and W. N. Shaw, M. A., F. R. S,, Reprinted from the ninth edition of the Encyclopædia Britannica, 1894. New York: Macmillan & Co.: London: Adam and Charles Black. 180 folio pages, illustrated. Price, $1.60.

The book, being as stated, a reprint of articles from the Encyclopædia Britannica, the original numbering of the pages is followed and does not always correspond with the actual pages of the present volume. The articles on electricity, electrometer and magnetism, are by Prof. Chrystal, and the article on electrolysis is by Prof. Shaw. Besides these there is a short article by F. W. Rudler, on electro-metallurgy, which is not mentioned on the title page. The Encyclopædia Britannica being so widely known, it is almost superfluous to review *in extenso* these reprinted articles. For the benefit of those who are not acquainted with the original, however, we will refer to them briefly.

The articles on electricity and magnetism, taken together form a short treatise, from which a very good general knowledge of these sciences may be obtained. The mode of treatment of the subjects may be characterized as an abridgement of Maxwell's work. That is, the mathematics are the same, only not carried so far, which makes it somewhat easier reading. It must not be inferred, however, that these articles are a mere epitome or synopsis of Maxwell's work, for the reading matter in itself is entitled to rank as an original treatise.

The article on electricity opens with the usual statements regarding the derivation of the word electricity from *ἤλεκτρον*-amber, and the observations of Thales in the year, 600 B. C., which were so thoroughly thrashed out in the columns of this journal a year and a half ago.

The original articles having been written a number of years ago, and not having been in any way revised in this reprint, may not be strictly up to date, but otherwise are most excellent and worthy of the honor which has been done them by publication in a separate book.

The article on electrolysis is for its length (eight and one-half pages) probably the best work on the subject in the English language. It is a purely theoretical article, as it should be; the practical applications belonging under other headings, such as electro-metallurgy, electroplating, etc. The article on electro-metallurgy, however, is rather unsatisfactory, and refers the reader who wants to know more to a number of other books on the subject. As, however, this article is thrown in gratis, and not even mentioned on the title page, any criticism of it does not apply to the present book, but to the Encyclopædia Britannica. Moreover, the article itself states that the cause of its limitation is the want of space.

The work in its present form is a very convenient size to handle, and more easily referred to than the encyclopædia volumes, so that it may be advantageous to electricians who already have the encyclopædia, but those who do not possess the encyclopædia, will certainly find it a valuable addition to their libraries.

## A New Insulation.

One of the most serious questions that confronts the builders and operators of dynamos and motors is how to prolong the life of such apparatus.

To eliminate the element of uncertainty that exists in electrical apparatus on account of the requirements of insulation has been the constant labor of designers, and while there has been a great advance in this direction, the problem is by no means solved as yet. By many builders the question of life has been made secondary to that of a higher efficiency.

It has been asserted that among the accidents that occur to dynamos and motors, fully 95 per cent. are directly attributable to the breaking down of the insulations, and yet the modern practice in designing dynamos and motors is to allow a minimum of space for insulation

in order to secure a maximum efficiency. This of course creates a necessity for a higher grade of insulation than ever before required—material having a high insulating value per mile in thickness as well as uniformity of such value; and above all, the property of elasticity so that it may withstand a considerable amount of bending—to which insulations are necessarily subjected in conforming them to the work—without cracking, as minute cracks in an insulation, however high in initial value, will of course reduce this value very materially, as is best illustrated in the case of mica. The higher the insulating value per mil, the more important this becomes. There has lately been placed on the market an insulation which claims to fulfill these requirements in a marked degree, by the Empire Electric Insulation Company of Schenectady, N. Y., who use a cloth or paper base and by coating it with successive layers of pure linseed oil, which is first treated by a special process, obtain an insulation which seems to meet all the requirements of modern practice. This insulation is made in the form of sheets of cloth and paper and in tape, and also pressed into shape for armature slots.

## A New Double-Voltage Dynamo.

A new machine called the Fuller double-voltage, automatic, constant potential dynamo is being placed upon the market by the Fontaine Crossing & Electrical Company, Detroit, Mich., for which a number of advantages are claimed. Among these are that the dynamo can be connected to any three-wire system without alteration in wiring throughout the building, and used equally as well with a two-wire system and for either of two voltages. For example, in a 100-hp generator the current can be taken at 110 volts or at 220, while any intermediate number of horse power from zero to full load can be taken at either voltage or both at the same time. The dynamo is, in fact, practically two machines in one. The company guarantees all machines to regulate within two volts from zero to full load with brushes practically at a fixed point of commutation.

Particular attention has been given to the mechanical construction of this machine, insuring long life, as the bearings are long and large in diameter. The field windings are of high resistance, while the armature windings are of low resistance, insuring long life, from the fact that heating is almost entirely avoided. The bearings are self-oiling and self-aligning, insuring perfect lubrication. This type of generator is kept in stock in sizes from 10 to 100-hp, and larger sizes built to order. All machines are guaranteed, both mechanically and electrically, for the period of two years from the time they are put in service.

The advantage of this machine is particularly apparent where 220-volt moters are in use, and it is desired to put in a lighting plant, as in this case the motors can be supplied with a 220-volt current, and the lighting circuits yet run at 110 volts.

In large cities, where floor space is valuable, it is obvious that where one machine is put in to do the work of two, the expense is greatly decreased; there is one foundation dispensed with, one belt and one clutch pulley, as well as the actual floor space, saved. In the ordinary system of lighting and power service, where two voltages are desired, it has always been necessary to couple two machines in series, thus making the first cost of the plant extremely high. While the cost of a dnyamo of this description is slightly higher than a single voltage dynamo, it is low when compared with the cost of two machines. To those who are engaged in building steamships, locomotives and general iron-working industries, where electrical cranes and portable electric drills are used, a machine of this description is valuable, for the reason that a current of electricity can be carried to a great distance for power purposes on economical sized wire, while the remainder of the machine can be used for lighting purposes. This will also apply to business blocks, where electrical elevators, pumps, electric ventilating fans and small machinery are used, as it is a measure of economy to run this class of machinery at the higher voltage.

## The Walker Street Railway Controller.

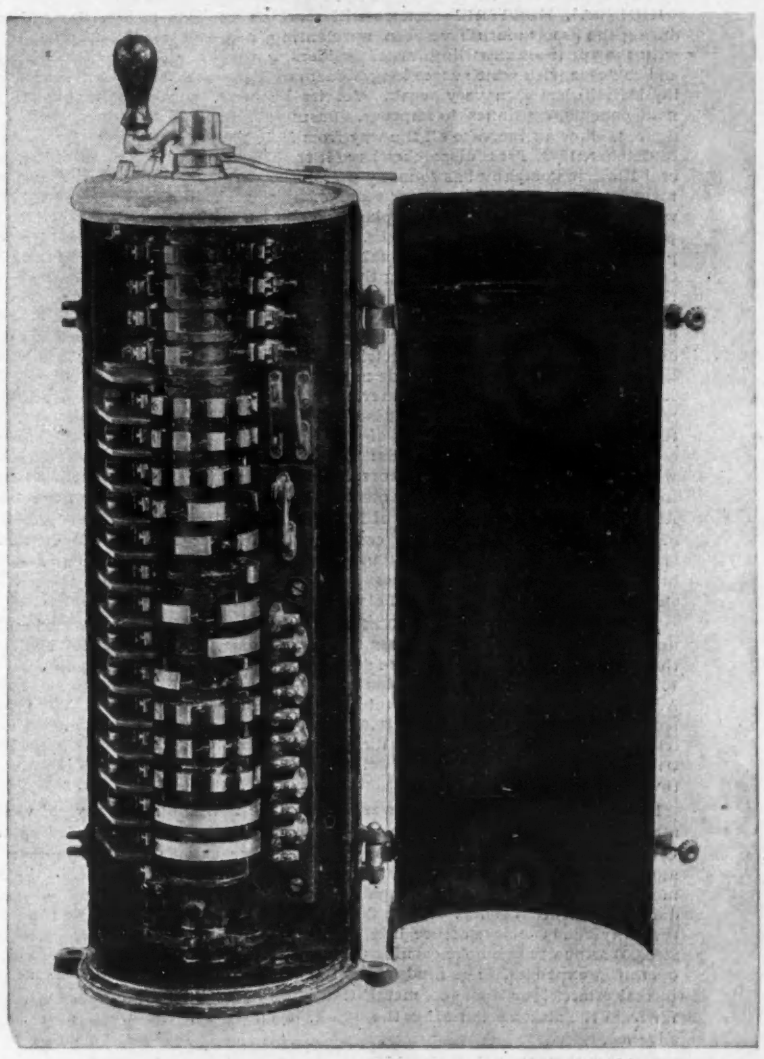
The Walker Manufacturing Company, Cleveland, O., which so recently brought out a new street railway motor equipment, has appreciated the fact that next in importance to the motor is the controlling apparatus for a car, and they have adopted the well-known plan of the series parallel controller, in which the two motors are first placed in series with each other, a sufficient rheostat being included in circuit to give the car a very easy and gentle start. While the motors themselves remain in series, this rheostat is cut out of the circuit by successive steps [until the motors remain in circuit purely in series, in which position they will run at one-half their maximum speed.

This arrangement makes a very perfect control in operating the cars through crowded streets within the city proper and enables the car to creep along very slowly without the loss of power, common to the old rheostatic control. It also avoids the heating up of any of the apparatus. For higher speed work the controller changes the connections of the motor from series to parallel position. In doing this the rheostat is again brought into service, preventing any jerk at the time the change is made, and is finally cut out entirely, for high speed the motors being in parallel.

Under these conditions the motors will make a speed of from 20 to 25 miles an hour on a level, and with the larger-sized equipments will make a speed of from 35 to 40 miles an hour on a level. The great difficulty which has been experienced in a switch control of this kind is to so combine the changes that undue sparking and arcing at the contacts of the switch, in the controller cylinder, may be avoided.

This is done by breaking the arc up into many little arcs, so small that they are harmless; for instance, with 500 volts pressure an arc can be drawn out 5 inches in length before it will break; if this arc be split up into 20 small arcs in series with one another, they will be but ¼ inch in length and will become harmless. Usually the arc from a controller, if there is but one break in circuit, will be about 2 inches in length, but in The Walker Manufacturing Company's controller this is broken up into ten parts, making a minute spark of only about 1-10 inch in length.

The "series" breaks of the spark is repeated in every movement of the controller in such a manner that the sparking is exceedingly slight, and cylinders which have been in operation for months, on grades even of 11 and 12 per cent. with 30-foot cars show no signs of damage whatever from sparking. There being no apparatus in the controller which consumes energy, the greatest possible economy results in its operation.



THE WALKER CONTROLLER.

The illustration gives an excellent idea of the appearance and construction of The Walker Manufacturing Company's controller. It is built very substantially, and the cover has an overhanging apron of about 1 inch, which prevents water from leaking into the interior of the controller. The cover must be dropped down from under the apron when it is open, and when put in place, is pushed up and held in position by thumb screws. This not only seals the joint at the top but also at the bottom of the controller. Where the cylinder shaft passes through the top, a perfectly water-tight joint is secured, so that a hose playing on the top of a controller for 24 hours will show no sign of water leaking through at any point.

The reversing and cylinder handles are interlocking, so that the motors cannot be reversed while the current is on, nor can the cylinder handle be turned when the reversing switch is off. The handles of the controller (both cylinder and reversing) cannot be removed unless they are in the "off" position; this is a very desirable feature to prevent accidents in running cars. All the parts of the controller are interchangeable, and simple in construction and design, and all of the wearing parts are replaceable.

# Financial Intelligence.

## The Electrical Stock Market.

New York, Nov. 3, 1894.

ELECTRIC STOCKS have been forcedly quiet this week. For several weeks now speculative activity, except in odd moments, has been an unknown quantity. It would seem that the revived conditions in business and the tremendous accumulation of funds at the various money centers would have resulted in the inception of a long-continued bull movement, and that electrical stocks, by reason of the prominence with which electric apparatus now figures in all industries, would hasten to enjoy some measure of advancing quotations. True, the rejuvination of commerce following on the settlement of the tariff agitation did result in a bull movement, but it was spasmodic. After the tentative advance came listlessness, to be interrupted at odd times only by successfully carried out bear campaigns. In consequence, electrical stocks to-day, though business conditions in the interval have immeasurably improved, are lower than a month ago, but merely as a result of professional manipulation.

GENERAL ELECTRIC matters will serve as an illustration. Bear attacks during the past month have been unrelenting, and the stock at times (what with the apparent unwillingness of insiders to render stock market supports, and the ease with which some long holders of the stock have been scared into liquidation) has been very weak. Yet its business, according to official announcements, continues to improve. Business returns for October, will, it is figured, show an increase all the way from 50 to 100 per cent. over the business of October, 1893. Press dispatches have it that the Schenectady plant of the General Electric Company has so many pressing orders on hand that the management has been obliged to send some of the work to the Thomson-Houston works at Lynn, which the latter plant is well equipped to do, so as to relieve the pressure on the Schenectady works. This additional call will entail the employment at Lynn of an additional force of about 400 operatives. One of the cheerful announcements effecting the company just made is the statement that the transfer books show a material increase as compared with a year ago, in the number of individual shareholders, while the number of shares in brokers' names is declining. An executive officer is quoted as saying: "There has been enormous buying of General Electric below 36 by interests which already have heavy lines. Owing to the wide nature of the holdings, the borrowing of the stock is a comparatively easy matter, and for this reason the heavy short interest which exists is not manifest." (It is on scaring this large and unwieldy short interest into cover that the friends of the company now mainly base their hopes of a rise.) This same official adds: "It is extremely improbable that any action will be taken looking toward a correction of the impairment of the capital before spring, and it is not by any means certain that it will be done at that time. At recent meetings of the Board of Directors the matter has not been presented or discussed in any form. The company, however, is making money, and is creating a surplus which is being used in making judicious loans and investments." One of the week's rumors had to do with President Coffin, who, it was stated, contemplated retiring. This is officially denied.

FORT WAYNE ELECTRIC COMPANY trust receipts have been placed on the unlisted department of the Boston Stock Exchange. These receipts represent the stock deposited with the State Street Safe Deposit & Trust Company, of Boston, and held by it in connection with the committee, Moses Williams, Frank A. Day and J. N. Smith, for the protection of the minority interests. The capital stock consists of 160,000 shares, 80,000 of which are owned by the General Electric Company. The second installment of 40 per cent. on the Fort Wayne Electric Corporation 6 per cent. gold debenture bonds was called for on the first of this month.

ERIE TELEPHONE has this week been made the subject of several vicious attacks; the governors of the Stock Exchange have, in fact, been called upon to correct what is called a "mistake" in placing Erie Telephone on the list. In answer to the various reports set forth reflecting on its credit, this official statement is promulgated by the company: "Our sub-companies do not owe one dollar of indebtedness. The Erie Company has paid over $1,700,000 in the forty-three dividends declared since July, 1883. It pays for repairs and reconstruction $150,000 annually from the earnings, in addition to dividends, royalties and all operating expenses. The funds raised by the bond sales are invested exclusively in real estate, long distance, metallic circuit and underground extensions." So far from the attacks harming the stock, it closes for the week at a slight advance.

BELL TELEPHONE stockholders, as intimated last week, will hold a special meeting in Boston on November 15, to accept or reject the act of the last Massachusetts legislature. The new stock is to be offered to stockholders at such price as may be determined by the Commissioner of Corporations, to be fixed under the provisions of the law. This will, it is expected, be the average price of the stock on the day of the meeting. Nothing, it is reported, has been done towards underwriting the stock, and it is not probable that anything will be, as the law provides that all stock not taken by stockholders shall be sold at auction. The stock continues weak. The net output for October was 3,346 instruments, a gain of 5,028 over October, 1893, when there was a deficit. Since December 20, 1893, the gross output has been 71,206, a loss of 1,085, and the net output 12,078, a decrease of 7,693.

AMERICAN DISTRICT TELEGRAPH, a stock not much quoted, is inclined to weakness, inasmuch as it is reported that at the meeting of the Board of Directors to be held next week the usual dividend will be passed by. Decreased earnings are given as the reason.

THE STREET RAILWAY AND ILLUMINATING PROPERTIES trustees, as announced last week, have purchased another lot of 499 shares of preferred stock at an average price of 100.19, making a total of 16,343 shares already cancelled.

THE NEW ENGLAND TELEPHONE & TELEGRAPH COMPANY, in declaring its dividend this week of $1 per share, has increased the annual dividend rate to 4 per cent., as against $3.50 per share distributed during 1893. The new Haymarket Exchange soon to be opened in Boston will greatly facilitate operations and also result in large economies.

CHICAGO EDISON COMPANY stock is now quoted at from 120 to 130, which is somewhat lower than former figures. There has recently been more than the usual amount of trading in the stock so that prices naturally reached the normally low rates. New York brokers offer 125 for this security.

ELECTRICAL STOCKS.

| | Par. | Bid. | Asked |
|---|---|---|---|
| Brush Ill., New York | 50 | 10 | 30 |
| Cleveland General Electric | 100 | 80 | 90 |
| Detroit Electrical Works | 10 | 3 | 4 |
| East River Electric Light Co. | 100 | — | 50 |
| Edison Electric Ill., New York | 100 | 100 | 101 |
| " " " Brooklyn | 100 | 110 | 112 |
| " " " Boston | 100 | 128 | 130 |
| Cichago Edison " Chicago | 100 | 120 | 130 |
| " " " Philadelphia | 100 | 120 | 125 |
| Edison Electric Light of Europe | 100 | 1 | 3 |
| Edison Ore Milling | 100 | 12 | 15 |
| Electric Construction & Supply Co., com. | 15 | 7⅛ | 10 |
| " " " " pref. | 15 | 7½ | 10 |
| Fort Wayne Electric | 100 | 2¼ | 2¾ |
| General Electric | 100 | 35 | 35½ |
| General Electric pref | 100 | 63 | 65 |
| Interior Conduit & Ins. Co. | 100 | 20 | 30 |
| Mount Morris Electric | 100 | 25 | 50 |
| Westinghouse Consolidated, com. | 50 | 35 | 36 |
| " " pref | 50 | 52½ | 53 |

BONDS.

| | | | |
|---|---|---|---|
| Edison Electric Ill., New York | 1,000 | 107¼ | 107⅜ |
| Edison Electric Light of Europe | 194 | 75 | 85 |
| General Electric Co., deb. 5's | 1,000 | 86 | 88 |

TELEGRAPH AND TELEPHONE.

| | | | |
|---|---|---|---|
| American Bell Telephone | 100 | 194⅛ | 195 |
| American District Telegraph | 100 | 40 | 45 |
| American Telegraph & Cable | 100 | 90½ | 91 |
| Central & South American Telegraph | 100 | 101½ | 105 |
| Commercial Cables | 100 | 125 | 145 |
| Erie Telephone | 100 | 53⅞ | 54 |
| Gold & Stock Telegraph | 100 | 103 | 105 |
| Mexican Telegraph | 100 | 180 | 190 |
| *New England Telephone | 100 | 67 | 69 |
| Postal Telegraph-Cable | 100 | 54 | 60 |
| Western Union Telegraph | 100 | 87 | 88 |

*Ex-div.

## New Incorporations.

THE MISSOURI DISTRICT TELEGRAPH COMPANY, Kansas City, Mo., capital stock $50,000, has been incorporated by L. C. Baker, M. D. Wood and J. W. Murphy.

THE MARYLAND SAFETY LIGHT, HEAT AND POWER COMPANY has been incorporated by Joseph Knell, Henry C. Barranger, E. C. Wallman, Geo. W. Knell and R. D. Bradley. The capital stock is $50,000.

THE PACIFIC ELECTRIC COMPANY, Pacific, Mo., capital stock $5,020, has been incorporated to erect a light and power plant. The promoters are A. H. Brown, A. Kappiz, G. H. Gross, S. B. Whitsett, C. C. Close, L. L. Seaburn and A. F. Mantel.

THE AMERICAN SAFETY HEAT AND LIGHT AND POWER COMPANY, Baltimore, Md., capital stock $50,000, has been incorporated by R. D. Bradley, G. M. Russum, Joseph Knell, G. W. Knell and G. L. Rogers, to manufacture appliances for lighting and heating buildings.

THE PIONEER ELECTRIC LIGHT COMPANY, of Barnet, Vt., capital stock $3,000, has been formed to furnish light and power in that town. H. E. Wilson, W. H. Burbank, Sherburn Moore, E. E. McGaffrey and H. A. Gilfillan, all of Barnet, are interested.

THE CHAPPAQUA ELECTRIC LIGHT AND POWER COMPANY, Chappaqua, N. Y., capital stock $30,000, has been incorporated, to manufacture and use electricity. Frank B. Sellick, Bertha G. Sellick, New York City, and Jas. S. Quinby, of Chappaqua, are interested.

THE EUREKA ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., capital stock $30,000, has been formed to manufacture and deal in electrical appliances, etc. Alfred Bevis, C. H. Longstretch, and Daniel W. Smith, all of St. Louis, are the promoters.

THE MOUNT GILEAD ELECTRIC LIGHT AND POWER COMPANY, Mount Gilead, O., capital stock $15,000, has been formed to build and operate an electric light and power plant. T. J. Carmack, Cleveland, O., and E. T. Bowen and M. J. Carmack are the incorporators.

THE ANCHOR ELECTRIC COMPANY, Portland, Me., capital stock $75,000, has been formed to manufacture and deal in electrical appliances and machinery. Philip M. Reynolds, Milton, Mass.; Horatio C. Hawks and Norman Marshall, Boston, Mass., are interested.

THE COOK ELEVATED ELECTRIC RAILWAY COMPANY, Chicago, Ill., capital stock $10,000,000, has been organized to construct elevated railways material and equipments relating thereto, etc. Mark Sands, Jas. E. Gaule and Carl H. Leopold are the incorporators.

THE HUNTERDON ELECTRIC COMPANY, Lambertville, N.J., capital stock $30,000, has been incorporated to manufacture, generate and store electricity for light, heat and power, etc. Wm. R. Bratten, Lenni; W. Alex. Robinson, and George W. Jacobs, Jr., Philadelphia, Pa., are the organizers.

THE MARBLE CITY WATER AND POWER COMPANY, Marble City, Col., capital stock $100,000, has been formed to construct a reservoir for water power and to furnish electric light to Marble City. Robt. Hayes Kline, Philadelpha, Pa.; Wm. W. Wood, Alex. J. Mitchell, Marble City, are the promoters.

THE CAPITAL ELECTRIC COMPANY, Springfield, Ill., capital stock $60,000, has been formed to produce and furnish electricity for light, heat and power, and to furnish electrical applicances, etc. John McCreery, Peter W. Harts, Fred D. Buke, George Pasfield and Edwin A. Wilson are interested.

THE ATTLEBOROUGH STEAM AND ELECTRIC COMPANY, Attleboro, Mass., capital stock $65,000, has been formed to generate and use electricity for light, heat and power, and to manufacture and deal in machinery used for that purpose. Wm. A. Walton, Wm. H. Haskell, Homer M. Daggett, Jr., and Theron J. Smith are the interested parties.

THE COLUMBIA, IRONVILLE AND MOUNTJOY STREET RAILWAY COMPANY, Philadelphia, Pa., capital stock $300,000, has been incorporated to construct, maintain and operate an electric railway. W. N. Boyer, Sam. R. Russell and Anthony H. Dillman, Philadelphia, are the promoters.

THE NATIONAL ELECTRIC COMPANY, Louisville, Ky., capital stock $20,000, has been formed to manufacture and sell electric cigar lighters and electrical devices of all kinds. James E. Gaither, J. W. Dawson, G. W. Eneby, J. C. Bowan, F. Eneby and J. M. Gilmore, Louisville, Ky., are the promoters.

THE AMERICAN INTERNATIONAL ELECTRIC COMPANY, Hawthorne, N. J., capital stock $200,000, has been formed to manufacture and sell electrical and other machinery and appliances. Henry B. Oakman, Frederick A. Bellevue, Brooklyn, N. Y., and Frank M. Ashley, Hawthorne, N. J., are the promoters.

THE CLEVELAND AND ELYRIA ELECTRIC RAILROAD COMPANY, Berea, O., capital stock $200,000, has been formed to construct, maintain and operate an electric railroad between Cleveland, Elyria, Wellington and Oberlin, and to furnish electric light, heat and power. F. T. Pomeroy, Berea, O., M. A. Sprague and A. W. Bishop are interested.

THE TYEE CONSOLIDATEED MINING COMPANY, San Francisco, Cal., capital stock $10,000,000, has been incorporated to do a mining and milling business; build and operate water works, electric light and power systems, steamboat lines and ferries, and to deal in merchandise. Maurice E. Griffin, Wm. B. Waycott and Richard E. Lewis are interested parties.

THE POWER DEVELOPMENT COMPANY, San Francisco, Cal., capital stock $500,000, has been incorporated to generate and develop water and electric power, deal in water rights, etc., and to transmit light and power for all purposes. Albert Miller, Edw. W. Hopkins, Chas. A. Grow, Chas. Webb Howard, San Francisco, and Carroll H. Beal, New York City, are the promoters.

# Special Correspondence.

## NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 Broadway, New York, Nov. 3, 1894.

THE BROOKLYN CITY AND NEWTOWN RAILWAY COMPANIES have been granted the right to enter Flushing.

J. JONES & SON, 67 Cortlandt Street, New York, report business excellent. They still have some of the A. B. & C. sockets in stock and just at present are making a specialty of cotton cord.

MR. FRANK W. HAWLEY, vice-president of the Cataract General Electric Companies, in an interview in the Syracuse "Post" strongly favors the improvement of the New York State canals, and that in order to wield any influence whatever on the great problem of transportation the canals must not only be improved but also electric propulsion adopted.

## NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, November 2, 1894.

WESTINGHOUSE, CHURCH, KERR & COMPANY announce the removal of their New Engalnd office from 620 Atlantic avenue to Exchange Building, 53 State street, Boston.

THE COLUMBIA ELECTRIC COMPANY, of Worcester, Mass., has just sold to the newly organized Grafton Electric Company, of Grafton, Mass., 25 miles of weather-proof wire.

THE HAWKS ELECTRIC COMPANY, of Boston, under the management of Mr. W. F. Fowler, will continue to do general construction work, and about December 1st will move into a new office on Franklin street.

MR. CHARLES H. POPE, who has hosts of friends in the electrical fraternity, owing to his connection with the mining and motor department of the Thomson-Houston Electric Company and with the Brown Electric Company as its cashier and bookkeeper, is now identified with the Thompson-Brown Electric Company, of Boston, as assistant treasurer.

MESSRS. LINTON & SOUTHWICK, of Worcester, Mass., maunfacturers of switches, switchboards and electrical appliances, report businesss as rapidly improving with them, and orders on the increase. They have recently again considerably enlarged their manufacturing facilities to meet the demand for their well known specialties. Some novelties which they have been developing will appear in their forthcoming catalogue.

MR. J. E. TALBOT, well and favorably known to the electrical fraternity everywhere, one among the oldest of the "old timers's so far as service is concerned, and more recently for six years prominently identified with the Fort Wayne Electric Company, at Indianapolis, has become associated with Messrs. Linton & Southwick, of Worcester. We congratulate the latter firm upon securing the valuable services of Mr. Talbot and congratulate also Mr. Talbot upon the good connection he has made.

THE DAVIDSON VENTILATING COMPANY reports business as improving in their electrical department. They have just completed the installation of 200 lights in the Chardon Street Telephone Exchange, Boston; also a 250-light Wenstrom dynamo and wiring complete in the W. Warren Thread Works, Westfield, Mass. They have also closed a contract for a 450-light plant for the Howland Falls Pulp Company, Howland Falls, Me. This company has taken the New England agency for the well-known engines and boilers manufactured by the Phœnix Iron Works Company, who have their factories in Meadville, Pa.

THE PETTINGELL-ANDREWS COMPANY, of Boston, reports the receipt of large orders for commutator segments manufactured by the Billings & Spencer Company, of Hartford, Conn, and for which they are the United States and Canadian selling agents. They have also just made a good sale of incandescent arc lamps, and their sales of line wire recently have been very gratifying. Altogether they report business as exceptionally good, and notwithstanding the fresh competition they are obliged to encounter, owing to the ormation of new supply houses in Boston, they confidently expect do hold well their trade. Competition always acts as an incitant to energy, of which Mr. Andrews, Mr. Price and their attaches possess an abundance, and some lively "hustling" may be anticipated on their part.

THE FOLLOWING HANDSOME AND DESERVED TRIBUTE appeared this week in the Boston Record in its "Seen and Heard" column: "W. J. Denver, assistant general manager of the New Enlgand Telephone and Telegraph Company, is one of the busiest men to be seen on Boston's streets. Aside from his office duties, and they are diverse and numerous enough to need 18 hours out of 24 in the life of any ordinary man, he is obliged to personally visit many cities and towns of New England every week of his life, superintend extensive constructive operations in one direction, and the proper maintenance of miles of equipment in another, and all the time he must keep himself fully informed of every improvement in electrical science and if possible originate a few himself. I do not envy him his position no matter what his salary or however much he likes it, even if I could perform the duties."

THE NEW ENGLAND AGENCY of the Buckeye Engine Company has removed from 84 Kingston street to 620 Atlantic avenue, Boston, where it is represented as before by Mr. W. D. Hoffman. The Buckeye Engine Company are to be congratulated upon re-establishing themselves in this district, in which up to last spring it was not strongly represented. With its many engines now running in all of the principal New England cities it always has a first-class record to point to. One of its large plants, a 100-hp triple expansion, at the Hadley Company Holyoke, Mass., is very conspicuous for its economy and general excellence. The Buckeye Company could not possibly be better represented than it will be by Mr. Hoffman, who understands its engine thoroughly, owing to the fact that his father was so long identified with its New England branch of manufacture, in addition to which Mr. Hoffman has also represented the engine in the West.

THE THOMPSON-BROWN ELECTRIC COMPANY opened its new and capacious store at 97 High street, Boston, Thursday, October 25, and its managers and attaches have every reason to congratulate themselves upon the large number of well-wishers who responded to their invitation during the day and evening, as well as upon the numerous lette of congratulation which were received from many prospective customers in England. A light lunch was provided, during the dispatch of which an orchestra discoursed some lively music. The occasion was a happy one in every respect. President Thompson received a most hearty welcome from all present and the countenances of Messrs. Maybin W. Brown, F. E. Pettingell, and Herbert P. Brown beamed with joy over the kindly words, congratulations and best wishes which were spoken. The company is already the recipient of some good orders, which, coming so soon, were somewhat of a surprise.

THE O. C. WHITE COMPANY, of Worcester, Mass., state that there has recently been an unusual demand for its adjustable incandescent lamp holder. Among the recent sales are 250 holders to the Stanley Electric Manufacturing Company, of Pittsfield, and 150 holders to Kent & Stanley, jewellers, of Providence, R. I. This holder is adapted more especially for machine shop work, but its applications are numerous. It possesses several features of merit and received an award at the World's Fair; it holds a lamp at any angle or position desired without the inconvenience of a dangling cord, and it "stays put." A ball and socket joint on the ceiling or wall allows an arm to move in any direction, and a second arm, sliding, and also jointed on the first, lengthens or shortens the total reach of the device, and by tension joints the lamp with its socket and shade can be brought close to a piece of work in a machine and handled with ease and safety. It is a decided improvement both from the freedom from injury to a swinging lamp, and by the lamp being held close to the work, and at the same time being easily pushed on one side.

THE ANCHOR ELECTRIC COMPANY, of Boston, Mass., a newly organized corporation, is announced as succeeding to the business of the Brown Electric Company, the supply business of the Hawks Electric Company, and the supply business of the Iona Manufacturing Company, all of which have been conspicuous among the electrical industries of Boston for a number of years. The new company has located at 71 Federal street, near Franklin street, Boston, where it will have handsome and spacious quarters for the conduct of its business, the ground floor embracing about 2,700 square feet, and the basement about 800 feet. It will carry a most complete stock of "up to date" supplies and specialties for electric lighting and electric railway purposes, and in fact everything needed in the electrical line. This combination makes the Anchor Electric Company at once a formidable competitor in the electrical supply field. The Brown Electric Company has always received good business recognition, the supply department of the Hawks Electric Company had grown to quite large proportions so as to interfere considerably with its construction department, and the Iona Manufacturing Company was about in the same position, the conduct of its supply business conflicting quite seriously with the manufacture of its various electrical specialties. From a managerial standpoint the new company occupies an enviable position of strength. Mr. H. C. Hawks, of the Hawks Electric Company, an energetic business man and who enjoys a deservedly excellent reputation in the electrical field, is its president; Mr. P. M. Reynolds, treasurer of the Brown Electric Company, and formerly identified with the mining and motor department of the Thomson-Houston Electric Company, noted for his reliability and business sagacity, is its treasurer, and Mr. Norman Marshall, of the Ionia Mfg. Company, shrewd, calculating and far-seeing in business matters, is its vice-president and secretary.

## CANADIAN NOTES.

OTTAWA, Nov. 1, 1894.

LONDON, ONT.—A charter has been issued to the London Electric Company, with a capital of $250,000.

PETROLIA, ONT.—A charter has been granted to the Petrolia Electric Light, Heat and Power Company, with a capital of $25,000.

OTTAWA.—A petition asking the Electric Railway Company to extend its line to Billings' Bridge is now being circulated for signatures.

THE TOWN COUNCIL OF AYLMER will meet especially to pass upon the proposals of Contractor Viau's Electric Railway Company.

THE OTTAWA CAR COMPANY has shipped three vestibule cars for the St. John (N. B.) Electric Railway, equipped with Westinghouse motors.

HAMILTON.—B. B. Osler, has written to the Mayor of Dundas, proposing that

for a bonus of $25,000 he will convert the Hamilton and Dundas street railway into an electric road.

MONTREAL.—Duncan McDonald has been appointed superintendent of the Montreal Street Railway. Mr. McDonald has been acting superintendent since Mr. Franklin's resignation.

THE ANNUAL MEETING of the shareholders of The Toronto & Scarboro Electric Railway, Light & Power Company, will be held on November 13th, at Toronto, for the election of directors.

JOHN P. MULLARKEY, of Montreal, the new General Manager of the Montreal Island Belt Railway, takes charge of his position Nov. 2. Mr. Mullarkey is a young man, having been born Oct. 11, 1857, at Aylmer, Que.

LONDON, ONT.—All the street cars in the city have been fitted with automatic registers which count the actual number of passengers carried by each car during the day. The amount in the money boxes must correspond with the registers.

# News of the Week.

## Telegraph and Telephone.

BELOIT, WIS.—G. L. Call, proprietor of the Beloit Electric light plant, has been granted a franchise by the Common Council for the construction and maintenance of a telephone exchange.

INDIANAPOLIS, IND.—The Phoenix National Telephone Company, of Indianapolis, has been organized with a capital stock of $100,000. The directors are: Martin Caldwell, John W. Parrish and Jacob Frankel.

FOSTORIA, O.—A new telephone exchange in competition with the Bell Telephone is an assured fact for this city. The new company will be known as the Citizens' Telephone & Message Company, and will begin the construction of a plant next week.

## Electric Light and Power.

EAST ORANGE, N. J.—It appears to be the prevailing opinion that an electr light plant would be of the greatest benefit to the township.

MOBERLY, MO.—The organization of a company is proposed to establish an electric light plant. J. S. Bowers can be addressed.

LEWISTON, ME.—The Council has ordered the enlargement of the portion of the pumping station which is to be used by the electric light plant.

HARRISBURG, Pa.—The foundations for the electirc light plant of the Cumberland Valley Electric Light Company, at Riverton, have been begun by contractor Alleman.

DUNLAP, IOWA.—A movement is now on foot among the business men to loan the city money with which electric lights will be operated in connection with the water works.

CANTON, O.—A franchise has been granted to the Canton Light, Heat & Power Company to construct, maintain and operate an electric light system. H. G. Schaub is City Clerk.

GRAHAM, VA.—The Graham-Bluefield Electric Light & Power Company has made the necessary financial arrangements for building its proposed plant and will commence work at once.

WEST NEWTON, MASS.—A hearing has been granted the Newton & Watertown Gas & Electric Lighting Company on the proposed establishment of a municipal plant for the city.

PORTSMOUTH, N. H.—At a meeting of the Board of Aldermen, Alderman Ham moved that the city clerk be authorized to issue proposals to light the city five years, which was accepted.

PORT HURON, MICH.—The Council at a a special meeting decided to present to the voters at the coming election a proposition to bond the city for $40,000 for the purchase of an electric light plant.

BUFFALO, N. Y.—The Niagara Falls Power Company has petitioned the Buffalo Board of Aldermen for permission to erect poles in that city for the purpose of transmitting electric power from their plant.

PITTSBURG, PA.—An electric light plant is about to be installed in a town near Pittsburg, arc and incandescent. Prices on goods can be mailed to W. Staub, superintendent, 1321 Bluff street, Pittsburg, to be in before Nov. 15.

GRAND RAPIDS, MICH.—The Grand Rapids School Furniture Company contemplates building a new engine house. They will put in a new engine to run the factory, and use the present engine to drive an electric lighting plant.

CUTHBERT, GA.—The engineer has been ordered to proceed with his work in making surveys and preparing plans, specifications, etc., for the electric light plant and water works system recently voted for. Robt. L. Moye is Mayor.

BROOKLYN, N. Y.—The Mutual Gas & Electric Company, A. W. Wannamaker, president, and Chas. H. Selig, secretary, applied to the Board for a franchise to make and supply gas and electricity for lighting purposes and erect the necessary poles, etc.

WASHINGTON, D. C.—Sealed proposals will be received until November 10th for manufacturing and placing in position in complete working order in the United States Buildings, at Houston, Lewiston, Me., Fremont, Neb., and Staunton, Va., combination gas and electric light fixtures. C. S. Hamlin is Acting Secretary of the Treasury, Washington, D. C.

SYRACUSE, N. Y.—It is announced that a new company will apply to the Common Council for a franchise permitting it to furnish electric lights and electricity for power purposes, to be known as the Citizens' Company. The capital is $150,000, and those interested are Wilber S. Peck, Judge S. B. Hahn, W. K. Pierce, and Paul T. Brady, all of Syracuse.

## The Electric Railway.

APPLETON, WIS.—The Inter-Urban Electric Railway has been granted a franchise to construct a railway.

LITITZ, PA.—About 70 men are at work grading for the electric railroad between Lititz and Kissie Hill.

TAMPA, FLA.—R. W. Easley and W. H. Kendrick propose to build an electric street car line direct to Palmetto Beach.

BATLE CREEK, MICH.—The contract to rebuild the Battle Creek Electric Street Railway, has been given to D. A. McGugan, of Davenport, Iowa.

JERSEY SHORE, PA.—Engineers will commence to make a survey of the route of the proposed trolley line from Jersey Shore to Nippenose Valley.

PENN YAN, N. Y.—Some trouble is being encountered in securing the right of way for the proposed new road from Parker's to Sturdevant's Landing.

STEVENS POINT, WIS.—The Stevens Point Electric Light Company has been granted a franchise for putting in an electric street car system at that place.

MARLBORO, MASS.—The stock of the proposed electric railroad between Marlboro and Westboro has nearly all been disposed of. The road is capitalized at $100,000.

PORT JERVIS, N. Y.—The Delaware Valley Electric Railway has secured a piece of property of Edward Bush, on which it will locate a tower house near Marshall's creek.

SOUTHINGTON, CONN.—A plan is under way, under the management of L. V. Walkeley, of Southington, to build an electric road from Meriden to Southington.

LITTLE ROCK, ARK.—A petition has been submitted to the city council urging the granting of a street railway franchise to H. F. Auton and Messrs. Fuller & Moss.

BOWLING GREEN, KY.—The right of way for an electric railway from Bowling Green to Perrysburg and Portage has been granted to E. H. McNight by the Commissioners.

HEMPSTEAD, L. I., N. Y.—The Hempstead Traction Company has made application for permission to operate a surface electric railway through certain streets of the village.

LEWISTON, N. Y.—Considerable interest is felt over the prospect of an electric railroad being built at once from the gorge at Niagara Falls to this place. Right of way has been secured.

CLEVELAND, O.—The County Commissioners have granted L. M. Coe, of Berea, a franchise to construct and operate an electric railroad to connect Chestnut Ridge with the Berea line.

COLESVILLE, N. Y.—An extension of the trolley system from Lancaster to Cowlesville will, it is said, soon be made. Col. A. Haskins and other citizens are at work raising the money required to extend the road.

GLOUCESTER, MASS.—The Gloucester & Rockport Street Railway Company began work on the electric road from Bass avenue across Good Harbor Beach to Brier Neck, a distance of 2½ miles.

BEREA, O.—The County Commissioners granted the Cleveland & Elyria Electric Road a franchise through the county to connect with the Cuyahoga franchise. L. H. Coe and A. H. Pomoroy are the promoters.

IRVINGTON, N. J.—A meeting was held by the Board of Trustees for the purpose of hearing the wishes of the residents of Irvington and the representatives of the electric railway companies concerning franchises.

ANNAPOLIS, MD.—H. Y. Brady, of Smith & Brady, contractors, of Baltimore, is preparing plans for building the electrical railroad of the Annapolis, Bay Ridge & Brighton Beach Railway Company.

KEY WEST, FLA.—John Jay Philbrick and associates are not ready yet to make arrangements towards building and equipping their electrical railroad. As soon as a charter is secured they will be ready to proceed with their plans.

FORT MADISON, IOWA.—The Fort Madison Street Railway Company is considering the matter of changing the motive power to electricity and extending its lines. J. B. Morrison of the Morrison Mfg. Co., is president.

SCRANTON, PA.—An ordinance has been passed permitting the Scranton North End Street Railway Company to construct its tracks and erect the necessary poles and operate the same by electricity on a number of streets.

HOMESTEAD, PA.—At the meeting of the Homestead Council the right of way ordinance to the Homestead Traction Company was finally passed. Mr. Bryce was appointed to investigate the project of erecting a borough electric lighting plant.

BALTIMORE, MD.—The Baltimore Traction Company intends building a half-mile of new road to connect its Arlington line with the Gwynn Oak Railway. The extension of its Edmondson avenue line to Mount Washington is also proposed.

LYKENS, PA.—The Williams' Valley Street Railway Company has been granted a charter at the State Department. Its capital stock is $100,000 and it is proposed to build a line from Reimer City, Schuylkill County, to Lykens, a distance of twelve miles.

POTTSTOWN, PA.—The Ringing Rocks Electric Railway Company held a meeting in Treasurer Shaner's office and transacted considerable business in connection with the proposed extension of the line from Ringing Hill to Boyerstown and New Berlinville.

MARSHALL, MO.—A syndicate composed of a number of California capitalists is carrying on negotiations at Marshall looking to the building of an electric railway between Miami and Sedalia by way of Marshall, Blue Lick and the great coal mines in that vicinity.

BALTIMORE, MD.—The Baltimore Traction Company has decided to substitute electric power on its Gilmore street cable line. The cable plant will be kept in condition for use in emergency. The company is also considering the changing of its Druid Hill avenue line to electricity. F. H. Hambleton is chief engineer.

EAST WAREHAM, MASS.—At the annual meeting of the East Wareham, Onset Bay & Piont Independence Street Railway Company, the following officers were elected: Thomas B. Griffith, president; Isaac B. Eldridge, treasurer; Benj. F. Gibbs, clerk. A committee was empowered to investigate the question of electric motive power.

NORRISTOWN, PA.—The officers of the Norristown and Chestnut Hill Passenger Electric Railway have been in Norristown arranging with the town

council for the immediate construction of their line. The company will begin work immediately and expect to have it completed and a circuit formed with Philadelphia by next December.

BROOKYLN, N. Y.—The new power station for the Nassau Electric Railway Company, at Brooklyn, N. Y., will be 10 feet wide and 150 feet long, and will be constructed entirely of iron and steel, the whole designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn. The roof will have an anti-condensation corrugated iron roof covering.

CATLETTSBURG, KY.—The City Council of Catlettsburg, Ky., has decided to sell the franchise for an electric street railway through the city on November 12, which is virtually surrendering to the local line the right that has been contested and withheld for the past three years. The line will be completed as soon as possible after that date.

NIAGARA FALLS, ONT.—A number of gentlemen, headed by Wm. Kyle, E. Hewitt and Bobert Y. Sexworth from Toronto, and W. Wright of Niagara Falls, Ont., appeared before the council with a plan to build an electric road from Niagara Falls, Ont., to Chippewa, and use the old Niagara Falls and Drummondville road franchise through the town, the cost to be $350,000.

CHESTER, PA.—The people interested in the construction of the Philadelphia & Delaware Electric Railway Company, which has a charter to construct a trolley road from Philadelphia to the Delaware State line, and has extensive franchises in South Chester, drove over the route. They were joined in this city by their counsel, Jos. H. Hinkson, and say they will commence operations early next week.

WEYMOUTH, MASS.—The Braintree & Weymouth Street Railway Company has been organized. The directors are John Keyser, Braintree, D. A. Brooks, Braintree, Edward W. Hunt, of Weymouth, and others. John Kelley was chosen president. It was voted that the president be authorized to petition the selectmen of Weymouth at the earliest possible time for a location from Lincoln Square to South Weymouth.

KANSAS CITY, MO.—The Kansas City Traction Company, which has recently been chartered, has for its purpose the construction of an electrical railroad that will connect the Kansas City Cable Railway with the West Side Electric Railway, of Kansas City. B. S. Coler, of Brooklyn, N. Y., is president; W. H. Lucas, of Kansas City, Mo., secretary, and F. D. Hutchings, of Kansas City, treasurer. It is said that the line will be built at once. The capital is $1,000,000.

McKEESPORT, PA.—There is another electric line in sight for McKeesport. The gentlemen interested have been thinking seriously of extending Schenley Park and Highland electric railway from the entrance to Schenley Park at Squirrel Hill, Pittsburg, to Brown's Hill bridge at Brown Station, and thence through Hempstead. They have decided to extend this line to Duquesne to connect with the White Traction line. R. G. Wood is interested, and S. J. McFarren is the manager of the road.

## MISCELLANEOUS NOTES

THE UNIVERSITY OF ILLINOIS on Nov. 15 will dedicate its new Engineering Hall and the same day President A. S. Draper will be inaugurated.

THE FEEDER AND MAIN SUIT.—Judge Green, on October 26, at Trenton ordered a reversal of his decision in the case of the feeder and main patent, and ordered that the defendant have judgment against the complainant, the Edison Electric Light Company, for the amount of costs taxed by the Clerk of the U. S. Circuit Court of Appeals; also that the defendant have judgment against the complainant for the further sum of $6,411.57, amount of costs taxed by the Clerk of the Trenton Court.

EXHIBITION OF AMERICAN MANUFACTURES.—The Lodge & Davis Machine Tool Company and other large manufacturers of Cincinnati have entered heartily into the movement to organize Exhibitions of American Manufactures in Mexico and the South American republic in conjunction with international displays from those countries, through which it is hoped that the market for goods manufactured in the United States may be extended. Owing to the large trade of Cincinnati with these countries and its central location it is proposed that the suggested convention of American manufacturers be held there. At this convention it is proposed to settle the details of the plans, whose realization should meet with the encouragement of every one who desires the United States to occupy the position it should in the trade with our sister republics.

NATIONAL SCHOOL OF ELECTRICITY.—A public meeting of the National School of Electricity was held in Philadelphia on Tuesday evening, October 30th and was presided over by Mr. Addison B. Burke. The greater part of the meeting was devoted to an explanation of the object and methods of this school, by the Secretary of the Corporation, Mr. J. Allen Hornsby. An address was made by Mr. W. W. Porter of that city, in which he called attention in an interesting way, to the almost innumerable applications of electricity at the present time, and showed how important it was even to such men as lawyers, doctors, merchants, etc., to have some knowledge of electricity. Prof. Houston being out of town, did not address the meeting as was announced. The meeting was well attended and the Secretary announced that he believed there would be enough applicants in Philadelphia to form at least four classes of about thirty each.

# Trade and Industrial Notes.

THE S. K. C. SPECIALTY COMPANY (Stanley-Kelley-Chesney), with a capital of $12,500, has been organized in Pittsfield, Mass., for the manufacture of small motors and minor electrical machinery.

THE FONTAINE CROSSING AND ELECTRICAL COMPANY, Detroit, Mich., in a twelve-page catalogue, describes the various electrical apparatus which it manufactures, which include the Fuller automatic single and double voltage dynamos, Fuller stationary motors and Fuller combination fan motors. A long list of flattering letters commendatory of the Fuller apparatus maintain the high claims made for the efficiency and reliability of this machinery.

THE YOUNG LOCK NUT COMPANY, 150 Broadway, New York, through its representative, R. D. Stewart, exhibited the Wrought Iron Bridge Company's flexible bracket for trolley lines at the Atlanta Convention. Our report inadvertently stated that no representative was present in connection with this exhibit. The Young Nut Company also exhibited its gravity nut lock, Brownley injector, the Brownley brake shoe and the Technic Electrical Work's rail bond.

THE OHIO BRASS COMPANY reports that its recent exhibit at the Atlanta Convention, which attracted so much attention, has already borne fruit in the shape of orders from many new customers. The increasing number of orders indicate a steady and healthy growth of business, and it may be said that this firm now ranks among the leading manufacturers of electric railway material. It reports sales of considerable size for the month of October, the list including no less than 30 prominent electric railways.

WILLIAM BIDDLE, JR., AND JAMES G. BIDDLE announce that their connection with Queen & Company, incorporated, Philadelphia, as joint managers of the physical and electrical departments has ceased. Mr. James G. Biddle, who was manager for five years of the sales department, comprising physical and electrical instruments, can be addressed at 119 S. Fourth street, Room 28, from where he will be pleased to communicate with prospective purchasers of scientific apparatus.

THE PHILADELPHIA ENGINEERING WORKS have just completed contracts with the Carnegie Gas Company, Pittsburg, for three 30x60-inch gas compressors, each driven by a 32x60-inch Philadelphia Corliss engine of their rolling mill type. They have also contracted with the Pittsburg Natural Gas Company for a pair of 30x60-inch gas compressors, each driven by a 24x60-inch Philadelphia Corliss engine. Also a pair of 30x60-inch gas compressors for the Ohio Valley Gas Company, each driven by a 26x60-inch Philadelphia Corliss engine. Also with Marshall Bros., of Philadelphia, for an 800-hp tandem compound condensing engine, of their rolling mill Corliss type, to drive tinplate mills. They are just shipping for the Chamberlain Coal Company, Pottsville, Pa., two 34x60-inch Philadelphia Corliss hoisting engines complete, with drums, brakes, etc. Also two 14x36-inch heavy Corliss engines for the same company to be used for their coal breaker, and to the Standard Steel Works, Burnham, Pa., a 15-ton revolving open-hearth steel furnace, together with gas producers, piping and chimneys. Their works are operated full force night and day, and prospects are very good for plenty of trade in the future.

THE MATHER ELECTRIC COMPANY, of Manchester, Conn., reports an increasing number of sales of apparatus for the month of October. The company now has orders ahead for three months and is operating its entire plant overtime until 10 o'clock every night. The following is a list of sales: Hartford & West Hartford Street Railway Company, Hartford, Conn. (2d order), 180-kw 500 volt generator; Hartford & West Hartord Street Railway Company, Hartford, Conn. (3rd order), 180-kw 500 volt generator; Bloomington City Railway Company, Bloomington, Ill., 100-kw 500 volt generator; Amory Manufacturing Company, Manchester, N. H., 80-kw 120 volt generator; Chalres R. Lewis Clothing Manufacturing Company, Belleville, Ill., 30-kw 120 volt generator; Stamford Hotel, Chicago, Ill., 45-kw 120 volt generator; John Jermyn, Scranton, Pa., 100-kw 500 volt generator; Southwest Virginia Improvement Company Pocahontas, Va., 60-kw 220 volt generator; Somers' Fuel Company, Belle Vernon, Ohio, 60-kw 220 volt generator; J. Holt Gates, Chicago, Ill. 60-kw 220 volt generator; J. Holt Gates, Chicago, Ill., 30-kw 120 volt generator; J. Holt Gates, Chicago, Ill., 100-kw 500 volt generator; Burtis & Howard, Minneapolis, Minn., 11-kw 220 volt dynamo; Stanley Electric Company, Pittsfield, Mass., 2-kw Manchester exciter; Jon s & LamsonMachine Company, Springfield, Vt., 350 light dynamo; Warren Shaw & Company, South Peabody, Mass., 250 light dynamo; Lewis Anderson & Company, Skowhegan, Me., 600 light dynamo; George Pappert Manufacturing Company, North Milwaukee, Wis., 150-light dynamo; H. B. Coho, New York City, 450 light dynamo; Cobb, Bates & Yexra, Fall River, Mass., 600 light dynamo; Chambers Electric Light & Power Company, Truro, N. S. (6th order), 600 light dynamo; Ohio State University, Columbus, Ohio (2d order) 15-hp Manchester motor; Sheriff of Hampden County, Springfield, Mass., 5-hp Manchester motor; Aetna Electric Works, Hartford, Conn., 6-hp Manchester motor; Charles R. Lewis Clothing Manufacturing Company, Belleville, Ill., 3-hp Manchester motor; Harry S. Anderson, Springfield, Mass., 600 ampere spceial dynamo. Shipments consisting of further October orders, and former orders; Bartram Hotel, Philadelphia, Pa., 245-kw direct connected machines; New Pittsburg Coal Company, New Pittsburg, Ohio, 60-kw 220 volt generator; Morris Coal Company, Sand Run, Ohio, 60-kw 220 volt generator; Henry R. Worthington & Company, Brooklyn, N. Y., 45-hp 220 volt generator, Jones Bros. Electric Company, Cincinnati, Ohio (7th order), 50-hp 220 volt generator; Connecticut River Paper Company, Holyoke, Mass., 700 light dynamo; Grenada Hotel, Chicago, Ill., 450 light dynamo; Leafe Bros., Winchester, Va., 50 light dynamo; Major & Loomis, Hartford, N. C., 25 light dynamo; George W. Furbeck, Chicago, Ill., 250 light dynamo; Badger Lumber Company, Kansas City, Mo., 100 light dynamo; Henry R. Worthington & Co., Brooklyn, N. Y., 600 light dynamo; Diamond Machine Company, Providence, R. I., 250 light dynomo; North Packing & Provision Company, Somerville, Mass., (3d order), 1,000 light dynamo; H. S. Sands, Fairmont, West Va., 450 light dynamo; Karl Knitting Mill, Northville, N. Y., 75 light dynamo; Bay State Distillery Company, East Cambridge, Mass., 350 light dynamo; Phelps Publishing Company, Springfield, Mass., 20-hp Manchester motor; Connecticut River Paper Company, Holyoke, Mass., 215-hp Manchester motor; Machinery Supply Company, Los Angeles, Cal., 5-hp Manchester motor; Meriden Britannia Company, N. Y. City (2d order), 5-hp Manchester motor; Machinery Supply Company, Los Angeiles, Cal., 3-hp Manchester motor; Machinery Supply Company, Los Angeles, Cal., 10-hp Manchester motor; B. F. Sturtevant & Company, Chicago, Ill., 10-hp Manchester motor; Electric Construction & Engineering Company, Detroit, Mich., 3-hp Manchester motor.

# Business Notices

BATTERY CUT-OUT, CHEAP.—Sensitive, reliable, never requires attention Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

TO WHOM IT MAY CONCERN.—Take notice that the co-partnership existing under the firm name of Bradley & Combs, doing business at Rochester, N. Y., has been mutually dissolved.

# Record of Electrical Patents.

UNITED STATES PATENTS ISSUED OCTOBER 23, 1874.

(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

527,826. CARBON FOR ELECTRIC LIGHTS: E. G. Acheson, Monongahela City, Pa. Application filed Aug. 25, 1894. This comprises an outer body of carbon and a core of carbide of silicon.

528,055. MAGNETIC SEPARATORS; W. H. Williams, Newark, N. J. Application filed Jan. 29, 1892. This comprises a hollow perforated magnetic separating drum, connections for producing an air blast from the interior of the drum outward through the perforated separating wall of the drum.

528,127. CIRCUIT CHANGER FOR ELECTRIC SIGNALING SYSTEMS; J. F. Hunter and S. H. Lough, Seattle, Wash. Application filed Sept. 2, 1892. This comprises a plurality of line circuits with signal transmitting devices, receiving instruments in each circuit, an extra battery and circuit normally disconnected from the main line circuits, and a circuit changer in each main line circuit for connecting the extra battery circuit with the main line.

UNITED STATES PATENTS ISSUED OCTOBER 30, 1894.

528,149. TROLLEY CATCHER; Woodson D. Cobb, Fort Worth, Tex. Application filed May 29, 1894. The combination with a pivotal trolley wheel of a spring actuated supporting frame, a catch for connecting the pole to the frame, a trip arranged at the free end of the pole for engagement with a trolley wire upon the dismounting of the trolley wheel from the wire and connections between the trip and catch.

528,184. ELECTRIC ARC LAMP; Rudolph Segedahl, Chicago, Ill. Application filed February 26, 1894. The combination with an electric arc lamp provided with means adapted to sustain the weight of same, of a resistance consisting of two parts, interposed between the circuit terminals and lamp terminals respectively, and secured to or located on each side of the frame structure of the lamp.

528,185. AUTOMATIC ELECTROMAGNETIC CUT-OUT; L. T. Stanley, Brooklyn, N. Y. Application filed August 22, 1893. The combination of a jacketed coil, a reciprocating core, the pivoted switch lever, co-operating contacts and magnetic pus rod extending through a diamagnetic bushing in the end of the jacket under the switch lever.

528,188. ELECTRIC TRANSFORMER; Elihu Thompson, Lynn, Mass. Application filed January 29, 1890. A core for transformers built up of laminæ or plates of sheet iron assembled together, each plate having a shorter and a longer arm, the inner length of the shorter arm being made approximately equal to the width of the longer arm and two sets of sai plates locate in each laminæ and the plates of each set placed with the ends of the shorter arms against the inner sides of the longer arms so as to leave two rectangular openings for the coils of wire.

528,189. THERMOSTAT; David W. Thompson, Chicago, Ill. Application filed November 19, 1889. A thermostat comprising a base, a compound strip or coil mounted thereon, independently adjustable contact points, a plate supporting the contact points and movably supported upon the base, and an adjusting screw engaged with the base and the movable plate for adjusting the latter, the base being provided with a plurality of wires secured at their ends in the base and placed over the surface of the same to afford bearings for the plate.

528,204. ARMATURE FOR DYNAMO ELECTRIC MACHINES AND METHOD OF MAKING SAME: Thos. H. Hicks, Detroit, Mich. Application filed July 14, 1894. In an electric machine, an armature having its conductor bobbins each composed of two divisions, with an encircling band of insulation between the divisions and the terminals of all the bobbins proceeding from the outer layer of the bobbins.

528,206. CONDUIT ELECTRIC RAILWAY; Julius L. Hornig, St. Louis, Mo. Application filed February 19, 1894. In combination with a conduit casing, of a plow having a depression in its upper edge and a projection having a chamber therein for carrying a lubricant.

528,243. RHEOSTAT; Montgomery Waddell, Bridgeport, Conn. Application filed September 6, 1893. A plate for rheostats having one or more of its edges crimped.

528,245. ELECTRIC RAILWAY SIGNAL; A. J. Wilson, Port Chester, N. Y. Application filed November 21, 1892. The combination of a series of track sections, each divided into a series of sub-sections, the inner sub-section of each section being also the outer sub-section of the succeeding section, a normally closed track circuit for each sub-section, an over-lapping signal circuit for each track section adapted to be operated upon a change in the electric condition of the track circuits.

528,246. ELECTRIC RAILWAY SIGNAL; A. J. Wilson, Port Chester, New York. Applicaiton filed December 16, 1892. The combination of a block of track divided into two or more sub-sections, a track circuit for each sub-section, a normally open signal circuit, means preceding the block for closing the signal circuit to operate the signal, and means included in the signal circuit for breaking it upon a change in the elcetric condition of each of the track circuits of the block.

528,268. OHM-METER; A. H. Armen, Lynn, Mass. Application filed April 21, 1894. This consists of a single cylinder and two distinct sets of resistance wires coiled about it at its respective ends, and with two distinct sets of brushes bearing upon the wires, in combination with the two arms of a Wheatstone bridge.

528,286. GALVANIC BATTERY; M. M. Clark, Chicago, Ill. Application filed May 27, 1893. The combination with the negative electrode having notches, of plates, and of insulating material, a sack having its ends secured respectively to the plates, and a solid depolarizer contained in the sack.

528,291. UNDERGROUND CONDUIT; J. F. Cummings, Detroit, Mich. Application filed January 16, 1894. The combination of a casing, apertured blocks at the end of the casing, ducts supported at opposite ends in the apertures of the blocks, and having extensions projecting beyond the blocks and the opposite ends being correspondingly retracted from the end.

528,301. ART OF COATING ELECTRIC CONDUCTORS; A. F. Montgomery, Lincoln, R. I. Application filed July 2, 1894 This consists in moving a covered conductor lengthwise through a vacuum chamber and through a liquid partly filling that chamber.

528,330. CONDUIT SYSTEM FOR ELECTRIC RAILWAYS; J. B. Linn, Cleveland, O. Application filed December 9, 1893. A slot rail formed of beams having a groove therein, a conductor in the bottom of the groove, and a channel iron in the top of the groove, and contacting boxes arranged between the beams, and also provided with grooves to form a continuation of the grooved slot rail.

528,345. TELEGRAPH KEY; C. F. Sebring, Leeds, Mo. Application filed July 2, 1894. This comprises a pivoted key-lever, electrically connected to one wire of the line, and provided with a contact pin, and a contact plate located below and out of contact with the contact pin, and electrically connected to the other wire of the line, a plate electrically connected through the base plates of the key and other connections to the lever, a lever pivotally supported by an arm of the plate and provided with a contact pin and a spring connected to the lever, and holding the contact pin yieldingly into engagement with the contact plate of the pivoted lever.

528,379. CLOSED CONDUIT ELECTRIC RAILWAY; J. F. McLaughlin, Philadelphia, Pa. Application filed May 10, 1894. This comprises a main conductor and a sectional working conductor in the conduit, and exposed sections seated in the top of the conduit and electrically connected to the sections of the conduit, and magnetically operated switches pivoted to the main conductor, formed with switch plates in operative relation to the underground sections of the working conductor and with armatures close to the top of the conduit.

528,430. ELECTRO-MAGNETIC SWITCH; J. G. Hartel, deceased, Keokuk, Ia. Application filed December 2, 1893. The combination of a spring actuated switch lever in the circuit of a motor, a spring catch for holding the switch lever against a contact, a pivoted lever connected with the catch and a weight normally held detachably on an arm of the lever, an armature and flexible connections between it and the pivoted lever.

528,440. REVERSING MECHANISM FOR ELECTRIC MOTORS; J. Mellen, Newport, Ky., and N. O. Goldsmith, Cincinnati, O. Application filed March 24, 1894. This comprises reversers and their terminals, and two alternate circuit connections with the motors, and cut-outs operated alternately by the transmitting mechanism of the motor to automatically cut-out its circuit.

528,444. ELECTRIC SIGNALLING APPARATUS FOR BLOCK SYSTEMS; M. S. Reilley, Washington, D. C. Application filed June 13, 1894. The combination with a semaphore arm, of a rock shaft having a lever connected thereto and provided with two or more armature-bearing arms, one of which is rigid on the shaft and the other loose, the latter having a segmental slot to receive a pin projecting from the surface of the rock-shaft, and two electro-magnets adapted to attract the armatures on the arms.

528,445. SECONDARY BATTERY; J. E. Rhetts, Salem, Ind. Application filed November 22, 1893. A series of negative and positive electrodes each consisting of a flattened leaden receptacle having ends and bottom closed and its side walls perforated, the alternate members of the series being provided at opposite ends with integral lugs projecting from their upper ends and forming two series of binding posts, the central lugs of each series being provided with two bolt holes and the remaining lugs of the respective series being bent inward laterally and bolted to the central lugs by bolts passed through the lower bolt holes.

528,465. ELECTRIC MACHINE FOR RAILWAY SYSTEMS; E. Deming, New York, N. Y. Application filed May 27, 1893. This comprises a vertically movable trip located in the path of the wheel, a vertically moving bar in the path of the trip, an electric switch carried by the bar, a spring bearing against the bar and resisting its action, a pivoted catch for engaging and retaining the bar in its lowest position, and a magnet whose armature is in the path of the catch.

528,477. SUPPLY SYSTEM FOR ELECTRIC RAILWAYS; C. H. Harkins, St. Louis, Mo. Application filed December 9, 1893. In an electric railway independent switches located at intervals along the track, each comprising a housing having a flexible portion, a pair of contact points located within the housing and projecting between the contact points so as to vibrate to one or the other and to stand out of contact with either of the contact points so as to vibrate to one or the other, and to stand out of contact with either of the points when the switch is at rest, and a brush secured to and carried by the flexible portion of the housing and adapted to be engaged by a plate on the moving car to vibrate the arm and bring it into contact with either of the points.

528,494. CLOSED CONDUIT FOR ELECTRICAL RAILWAYS; Wm. F. Stearns, Berlin, Conn. Application filed April 7, 1894. In an electrical railway system, the combination of a compressible insulating envelope, an electric conductor mounted therein, a series of contact strips carried by said envelope, a traveling trolley plate having a downwardly extending offset portion for shedding water and a series of trolley wheels journaled on fixed arbors carried by said trolley plate and mounted to have free lateral movement.